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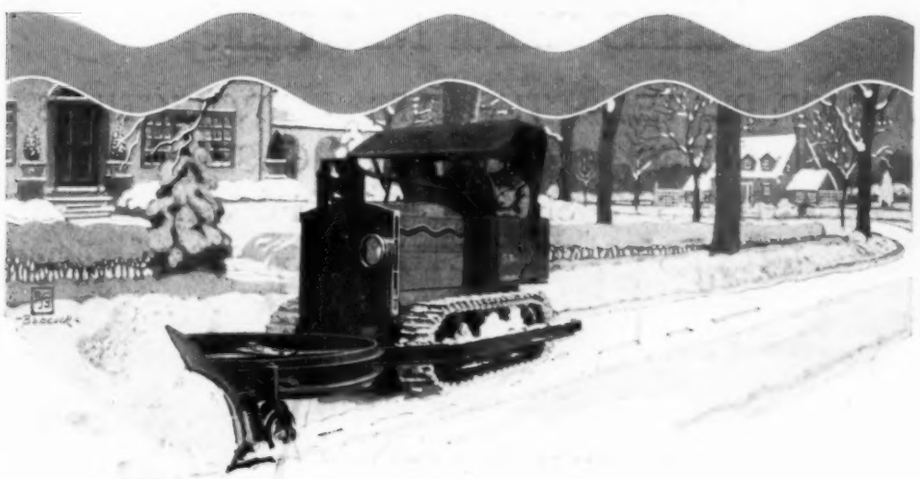

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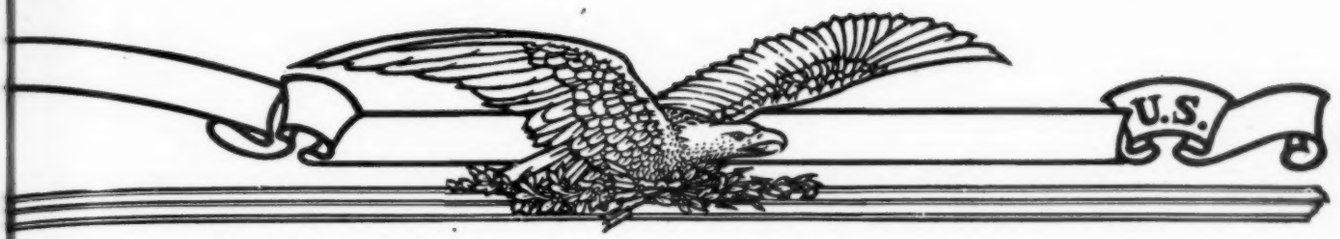

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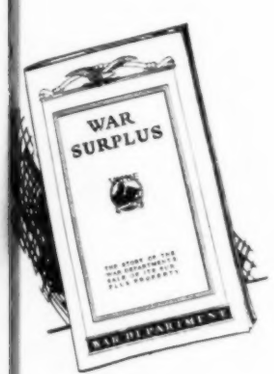

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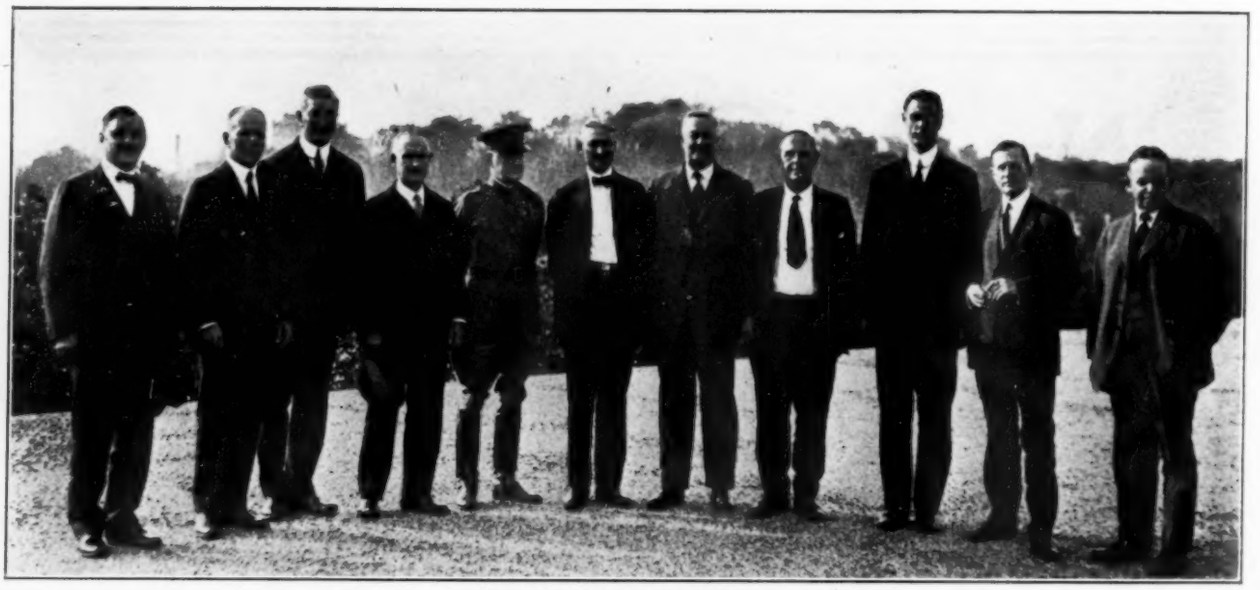


Meeting of Ordnance District Chiefs

LEFT TO RIGHT: COL. B. A. FRANKLIN, GEN. W. S. PEIRCE, MR. J. C. JONES, COL. J. M. WAINWRIGHT, GEN. JAS. G. HARBORD, MR. FRED J. ROBINSON, MR. M. E. SINGLETON, MR. C. L. HARRISON, COL. JOHN ROSS DELAFIELD, MR. E. A. RUSSELL, COL. H. C. TENNEY.

The first meeting of the Chiefs of the Ordnance Districts was held in the office of the Chief of Ordnance on October 5, 1922. Nine of the thirteen districts were represented at this meeting as follows:

Col. C. H. Tenney, Boston District; Col. B. A. Franklin, Bridgeport District; Mr. E. A. Russell, Chicago District; Mr. C. L. Harrison, Cincinnati District; Col. Bascom Little, Cleveland District; Mr. Fred J. Robinson, Detroit District; Col. John Ross Delafield, New York District; Mr. J. C. Jones, Philadelphia District; Mr. M. E. Singleton, St. Louis District.

Colonel J. Mayhew Wainwright, the Assistant Secretary of War; General Jas. G. Harbord, the Deputy Chief of Staff; General W. S. Peirce, Acting Chief of Ordnance; Col. H. B. Ferguson, Chief of Procurement, Office of the Assistant Secretary of War; the Commanding Officers of the principal Ordnance Arsenals, and the executive assistants of the District Chiefs and several other Ordnance Officers were present.

The meeting was devoted to a general discussion of the problem of ordnance procurement in war, the organization proposed for handling it and various difficulties which will be encountered in the work. The Assistant Secretary of War and the Deputy Chief of Staff addressed the meeting briefly.

Industrial Mobilization

By

JOHN W. WEEKS
Secretary of War

[The following address was delivered by the Secretary of War before the New York Post of the Army Ordnance Association on October 23. It is of equal interest to every member of the Association at large and we are therefore pleased to have the privilege of printing it in ARMY ORDNANCE for the benefit of our readers.—ED.]

THE Secretary of War has a multitude of duties thrust upon him by law and custom. Some of them are definite and well defined, while others are intangible with ill-defined limits that from the very nature of things cannot be determined. Of these latter his most important duty has to do with the problems of adequate national preparedness, and it is this subject which I shall discuss briefly.

Before I start my discussion I want to impress on my audience that I am not here to make a political speech. In treating the subject of national preparedness, I shall deal with facts concerning our state of preparedness or lack of preparedness. I do not intend to criticise the administration of President Wilson. It has made its record. Whatever good or bad there is in the record must stand. I am willing to admit the reasonableness of honest differences in opinion as to the causes of our unpreparedness when we entered the World War, but the fact remains that we entered the war totally unprepared.

John W. Weeks

Let me give you several instances of the conditions existing in 1917 after the United States had formally declared war on Germany. The first definite order for rifles was not placed until June 1, 1917, about seven weeks after the war had actually started. Six months after we had entered the war a commanding general of one of our Army camps, where a division had been mobilized and was being trained for overseas service, reported that his division had no machine guns, but forty-one per cent of its complement of rifles, twelve per cent of the 3-inch guns required, twenty-five per cent of its infantry equipment, and only ten per cent of the artillery ammunition needed. It was just about this time that General Pershing cabled the War Department from France that "The failure to land supplies of winter clothing has produced a serious condition."

In April of 1918, one year after we had entered the war, an investigating committee disclosed the fact that our huge expenditures for the construction of combat planes so greatly needed on the Western front had been largely thrown away and we actually had managed to construct but 15 combat planes, of which number one had reached France. In April of 1918 there was not a single American fighting plane on the battle front and two months later, when the great drive which ended the war started, our first fighting plane had not reached the front. Practically no American guns of large calibre were used in France and the war was practically over before we had reached a quantity production of heavy ordnance in America. The fighting had ended before we were able to get any amount of high explosive ammunition to the front or any number of guns above 3-inch calibre. I think I am correct in stating that with the exception of some railroad artillery, no American gun of more than 6-inch calibre was used against the enemy. We had no tanks. Not an American manufactured tank reached the battle front.

In the glory of victory it is easy to forget these facts and it is not a pleasant duty to hold post mor-

tems over what we failed to do in the war. But the conditions to which I have just referred are facts we cannot get away from and it would be the height of folly for us to delay the consideration of these matters until a more convenient season. America must not be found unprepared for another emergency.

At the close of the war, General Pershing in his preliminary report of November 20, 1918, said:

> Our entry into the war found us with a few of the auxiliaries necessary for its conduct in the modern sense. Among our most important deficiencies in material were artillery, aviation and tanks. In order to meet our requirements as rapidly as possible, we accepted the offer of the French Government to provide us with the necessary artillery equipment for thirty divisions. . . . Although we soon began the manufacture of these classes of guns at home, there were no guns of the calibres mentioned manufactured in America on our front at the date the armistice was signed. The only guns of those types produced at home thus far received in France are 109 three-inch guns.
>
> In aviation, we were in the same situation, and here again the French government came to our aid. We obtained from the French the necessary planes for the training of our personnel; they have provided us with a total of 2,676 pursuit, observation and bombing planes. The first airplanes received from home arrived in May, 1918. The first American squadron completely equipped by American production crossed the German lines August 7. As to tanks, we were also compelled to rely upon the French.

Of course, our unpreparedness in 1917 could not have been entirely prevented. Public sentiment in America would not have sanctioned the enormous appropriations necessary for preparation on the mammoth scale required. The mind of man was incapable of visualizing such a world conflagration as started in 1914, but America can find little excuse for not reading the writing on the wall after all Europe had become involved in the war. We stood for months on the brink of this vortex without even making our own footing secure. Our failure to do so is represented in hundreds of millions of dollars of annual interest charges and the care of thousands of disabled veterans. Of course, we could not have entered the war without loss of men or the expenditure of great amounts of money, but if we had been prepared the World War would have been ended much sooner, our loss of life would not have been as great, and many millions of dollars would not have been wasted in unproductive activity.

Is America drifting back to its short-sighted, careless and happy-go-lucky attitude of the early days of the European war toward this vitally important matter? I am afraid it is. I have no patience with the groups of silly pacifists in this country who are seeking universal peace through undermining with their insidious propaganda the ability of their own country to protect itself. What do these people see in the signs of the times to deceive themselves into believing that we can disarm while others arm? In what way has human nature changed since 1914? Are these people who are clamoring for our disarmament without any consideration to what other nations are doing in this regard willing to be consistent? Are they willing to remove the locks from their doors and the policemen from their streets? Of course not; but that in effect is what they are asking their country to do. A country of such great population and with such immeasurable resources—so great that it can carry twenty-three billions dollars of indebtedness at par and its people more than three times over-subscribe a half billion issue of four and one-quarter per cent bonds—without a sufficient national police force is in a ridiculous position.

The United States should have an army of one hundred and fifty thousand men. If we are going to carry out the provisions of the National Defense Act of 1920, we need thirteen thousand officers. The necessity for such a force is difficult to prove by mathematical computation. The small army man will say, "Why not twelve thousand officers?" The army might possibly get on temporarily with but twelve thousand officers, but when in every other walk of life we turn to the expert for advice why do we turn to the uninformed for advice in matters pertaining to the military? That is just what we are doing. The directing forces of our successful armies in France are still in the harness. They have had the actual experience of developing an army into an effective fighting machine. How futile it is to neglect their opinion and follow that of some comparatively obscure and totally inexperienced person guided largely by prejudice who happens temporarily to be in an official position where he can make his opinions effective.

To quote General Pershing again, in a recent memorandum he said:

> Had the United States in the spring of 1917 possessed twenty-five or thirty divisions completely organized and equipped but only sufficiently trained to meet the requirements of the "National position in readiness," each of these divisions would have been advanced many months compared with the many new divisions it was necessary to create.

With the exception of the Regular Army not one of the divisions sent to France was sufficiently trained to take its place in the allied line until some months after war had been declared. This delay prolonged hostilities, meant increased loss of life, and added to the vast indebtedness incurred by our Government. General Harbord in a recent address made a very apt reference to this situation. He said:

> The size of our debt incurred through unpreparedness brings a demand for economy and we continue unprepared. Thus unpreparedness brings the debt and the debt continues unpreparedness.

My remarks have had more particularly to do with actual military preparedness. If Congress will give the War Department sufficient appropriations to carry out the provisions of the National Defense Act, we can develop the man-power of the nation and gradually create reserves which will provide an effective fighting force in the event of an emergency. But I now wish to devote a few moments to discussing the industrial phase of preparedness.

In some respects industrial preparedness is more important than development of man power, because of the great length of time it requires to prepare industrially. The events of the last eight years have increased almost in geometric ratio the proportions of the particular problem of securing adequate industrial preparation, and I assure you it is with a real sense of gratification that I have an opportunity to come here to discuss this matter with those who were largely instrumental in bringing about what was done in 1917 and 1918 and who have indicated their willingness and patriotic determination to help the Government in the future, for it is a real patriotic service. It is not the kind of work that brings flaring headlines or publicity, but it is all important and requires the devotion of much time and exceptional ability in order to make it effective. If we do not have a care, and if it were not for the assurance of your support, I am fearful that our plans for industrial preparedness would follow the course of previous military efforts—expanding and taking form during war and contracting and becoming formless during times of peace when the possibility of war seems far removed.

During the years succeeding the Civil War military development and the profession of arms were at a standstill. Those who were in a position to speak authoritatively and advisedly as a result of their war experience were on the borders engaging in Indian warfare, far removed from the possibility of affecting public opinion or influencing Congressional action. Civil War literature is devoted more largely to personal and political matters, to clearing or enhancing political and partisan reputations, than in demonstrating the economic unsoundness of our unpreparedness for that struggle. The interest of our people turned from warfare to the development of the resources of the west. The possibility of another war seemed very remote, and if it had not been for the difficulties with the Indians it is very likely that the Regular Army would have disappeared. As it was, the Army was reduced to what practically constituted an Indian police force and much of the time it was insufficient even for that purpose.

The Spanish War came unexpectedly and found us entirely unprepared. Only the greater inefficieney and weakness of the enemy saved us from a prolonged and disastrous war. The Spanish War furnished us a valuable lesson and fortunately the country profited by its lesson. As a result of our experience in this war we established a system of army schools for the study of war problems, the preparation of plans of campaign, and for the training of its commissioned personnel. I include the General Staff in this system of schools, because it proved to be in its operation the best and final place for training which is absolutely essential. Now and then we hear criticism of the General Staff, but my experience of eighteen months in the War Department has convinced me that it is the only logical means through which an effective military organization can be administered. But to return to the lessons of the war with Spain, we established a service school at Leavenworth, Kansas, followed in more recent years by the schools at Riley, Benning, Bragg, and finally the Army War College.

Elihu Root, one of the most distinguished Secretaries of War the country has ever had, perhaps more than any other man in or out of the military service is entitled to the credit for having correctly interpreted the lessons of previous wars, and while it is possibly difficult to accurately determine the real value of the General Staff and the Army service schools in developing the personnel of the Army, there is no doubt but what much of the success our forces obtained in Europe is due to these agencies. It has been estimated that at least fifty per cent of the officers who greatly distinguished themselves in handling large bodies of troops and in the service of supply had either graduated from the service schools or had served on the General Staff during times of peace.

We did not handle the industrial end of our requirements adequately or wisely in the first months of the war. I have already referred to the conditions at that time, but if we have learned anything from the World War we will do in the industrial field what the President and the Secretary of War did twenty years ago to overcome the proven deficiencies of our fighting forces. We must develop and perfect the industrial forces to adequately support the fighting forces.

First, we must counteract indifference and, secondly, forget the idea which is somewhat prevalent that we did a good job in this war and will do even better in another one. I am willing to admit this contention as far as the immediate future, but what about ten, twenty, thirty or more years from now when the veterans of this war have disappeared? How can the coming generations be protected and benefited by the lessons of this war unless there is an organization perfected to perpetuate them. We must call into this service men who served in the World War

and who can give the nation the benefit of their experience. A systematic plan must be worked out to insure economic preparedness.

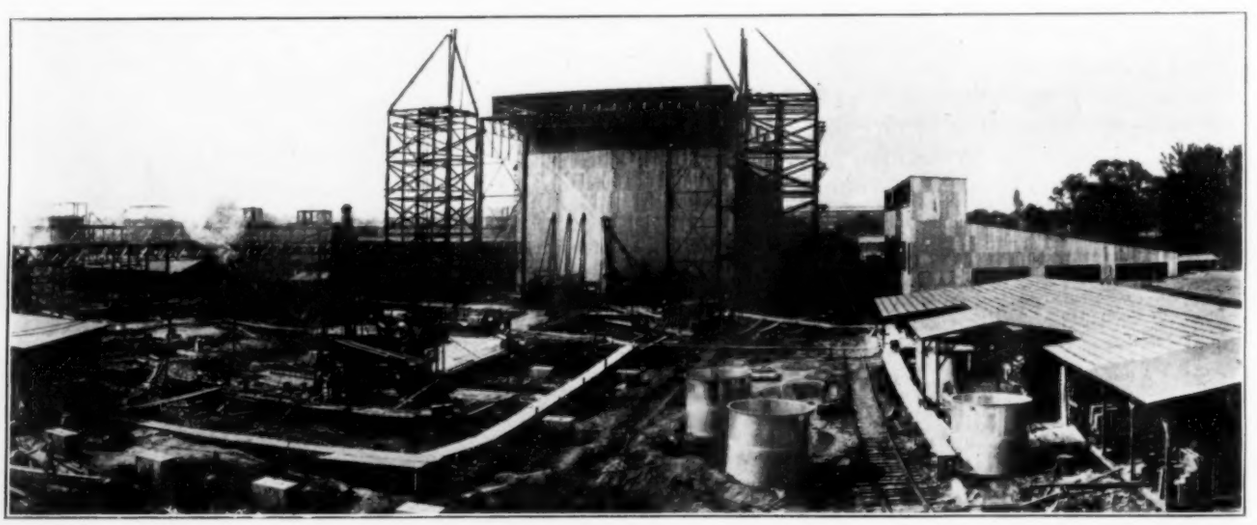
The Act of June 4, 1920, places upon the Assistant Secretary of War a heavy responsibility in charging him with the "assurance of adequate provision for the mobilization of material and industrial organizations essential to war time needs." I have only referred to this problem in the broadest terms because Colonel Wainwright is here and he will no doubt treat this subject in more detail. In any event, he is doing a great work. He will have the utmost cooperation and assistance from his associates in the Department, but he needs more than that—the patriotic support and services of the professional men, engineers, manufacturers, and business men of the country. Colonel Wainwright is developing his plans along broad and progressive lines, and his work is a permanent contribution to future national preparedness.

Speaking very generally, the country has been divided into ordnance districts. These districts are headed by men of the highest ability and experience and this work will be carried on under their direction. It is hardly necessary for me to refresh your minds with reference to the time and effort required to provide the plants necessary to furnish the country with ordnance during the war. Before the close of the war these plants were functioning and an enormous amount of ordnance material was produced. The ammunition on hand at the end of the war cost approximately $2,000,000,000, but the problem which presented the greatest difficulty was the development of plants capable of manufacturing heavy ordnance.

Even in this period of economy we are trying to keep our national arsenals open and to retain the more experienced men in the service in order to preserve a nucleus on which to build in the event of the necessity of expanding our operations. It is difficult to secure sufficient appropriations for this purpose from Congress because we do not need ordnance at this time. We are attempting, however, to hold a sufficient force in order to continue experimental work which is essential if we expect to keep prepared. You can well judge of how little can be done in maintaining an efficient ordnance service when the appropriation for ordnance this year is materially less than it was before the World War. On January 1, 1923, we will have a smaller force employed in our arsenals than at any time in the last twenty years.

Arsenals, however, are not as important to the Army as those plants connected with the steel industry which were developed for specific purposes during the war. Now that the war is over the owners of these plants find them to be serious burdens. Generally speaking, they can not be adjusted to the ordinary requirements of the manufacturing industry, and if the country were in a financial position to warrant the expenditure I believe we should subsidize those plants and keep them ready for the Government's purposes as we do our arsenals. I do not anticipate that such action can be taken at this time, but unless some plan is provided to maintain these plants we will gradually see them demolished, their machinery diverted to industrial purposes or scrapped, and when another emergency arises we will find ourselves in the position of the country in 1917. This is a very serious condition and it is receiving the careful consideration of the War Department. We are attempting to work out some indirect means of saving these plants to the Government.

Therefore, I cannot fail to once more express to you my very great appreciation of your willingness to undertake this important task.



Industrial Mobilization in 1918

The Horse and the Motor in War

By

Major General W. A. HOLBROOK
Chief of Cavalry

IT was as a beast of burden that the horse first served man. Later came his use for riding purposes. With the invention of the sledge and of the wheel his employment in transportation became more widely extended, the ox and then the mule sharing in this; the former especially establishing himself in the older and in the less progressive communities.

Like almost all animate and inanimate agencies of accomplishment, the horse was improved and his usefulness developed as a result of the strife of war. Greed of conquest, disputed titles to thrones, the clash of religions and the many long drawn out struggles between democracy and autocracy—all these spent their energies in terms of the strength and capabilities of the horse, as well as those of man.

General Holbrook

The scythe-armed chariots of the Persians, the highly ornamented bowman's car of the early Egyptians and the low battle chariot of the Greek spearmen demanded for their highest effectiveness the strongest and best trained horses. At about the time when tradition merged into definitely recorded history, the horse-drawn car of battle disappeared, presumably because the rough terrains of Greece and of Italy were little suited to the use of wheels. Thenceforth for many generations the horse participated in combat solely as a charger carrying his warrior master on his back into the forest of enemy spears and lances or among the swords and scimitars. Finally, when gunpowder came, the horse, fully equal to the occasion, made good the great cavalry charges of history, galloping magnificently into the mouths of cannon and against the ranks of riflemen. Likewise, in our own day, during the great World War, the horse has lived up to his heroic traditions. Several splendidly successful charges were made by brigades of horsemen against artillery in action, against infantry, and, in three instances, against troops in trenches.

The German army advancing through Belgium and France covered its front with patrols or groups of horsemen. Between these and the British and French troopers came the initial clashes of the great conflict. The horsemen of France and of Britain, during September, October and November, 1914, fighting and stopping the enemy daily, enabled four great armies, three French and one British, to deploy in safety, thus ensuring the successful prolongation of the Allied line to the sea.

Well-known now are the words of the British Commander—Lord French: "The greatest threat of disaster with which we were faced in 1914 was staved off by the devoted bravery and endurance displayed by the Cavalry Corps, under a Commander—General Allenby—who handled them throughout with consummate skill."

Equally familiar to us are the striking successes of the horsemen of Great Britain in their conquest of the Holy Land and almost complete destruction of the Turkish armies opposed to them. It can not be said that these great campaigns of General Allenby in Palestine and Syria were exclusively the affairs of horsemen—and no such claim is made—it is sufficient to say that those victories would have been impossible of achievement in extent and in results had not the horse and his rider been utilized as they were, in such numbers.

Coincident with the stirring battle achievements of the cavalry horse throughout the centuries, the artillery horse, dragging up the guns, has patiently contributed a vital service and has suffered his full share of battle casualties. Likewise, the draft horse, aided by the mule, has given essential assistance in the work of drawing to the front the wagons of the supply services. These wagons, in the development of mechanics, have presented every variety of design, from the two-wheeled cart of the early times to the six-line team and the four-horse wagon of later days.

Another activity participated in by the horse in all wars is that of scouting. A steed, fleet of foot and lightly equipped, serves to carry his rider not into the main battle but far in front or out on the flanks searching for information, which, in its highest value, may decide the battle. In addition to this great work of reconnaissance prior to battle, the mounted scout serves to keep in touch with a retreating force, or rapidly follows the trail of an elusive enemy as in the days of our own American Indian wars.

Thus we see the horse as the chariot steed, as the mount of the embattled knight, as the cavalryman's charger, as the gun-horse of the artillery, as the "seven-league boots" of the scout, and as the reliance of all armies in bearing burdens and drawing the supply wagons.

Now comes the motor with all its magic; moving men, guns and supplies in land warfare and making possible the attack and the observation of the enemy from the air. In

hasty misinterpretation of the motor's real effect, there have been many who have said that the horse's mission in war has now terminated and that Cavalry is obsolete. Indeed there are those who, infatuated completely by new marvels of mechanics, believe that man himself is a secondary consideration on the battlefield. In fact, both horse and man will have about the same general mission in future battles as they have had in the past, only each must be more highly trained than ever before.

In a theater of operations offering permanent, metaled roads the motor has definitely replaced the horse in hauling supplies along the main routes which lead from rail-head toward the area of actual combat. Motor transportation, under such conditions, may be viewed as a prolongation of the railroad lines, or, as a substitute, pending their installation. In France, where the contending armies fought in a region affording possibly the most extensive system of the best roads in the world, this was true. On the Italian front, outside the mountain sectors, the situation was the same. In Macedonia, motor transportation had to confess the superiority of animal-drawn transportation throughout the rough country which constituted a wide belt behind the front lines. On the front in Russia, the lack of roads made reliance on wagons a necessity in the rainy season. In Palestine, during the first part of the Jerusalem campaign the deep sand and the absence of roads made the use of automobile trucks impracticable, and wagons, together with camels, comprised the transport in Beersheba, for initial operations. During the subsequent advance the motor came up to expectations until the rains of December converted the plains of Philistia into a great crust of sticky mud, and then, there being practically no roads, the motor trucks encountered baffling conditions. In Mesopotamia, the long advance from the sea to Bagdad and beyond, was along the banks of the Tigris, the army operating necessarily on a narrow front with the river steamers and barges delivering supplies at points from which long hauls were the exception. On this front the small motor car was exceptionally useful in the dry season. On the American continent, our expedition into Mexico in 1916 afforded the motor an opportunity to demonstrate its usefulness only on the main lines of supply, especially in the role of substitute for rail lines.

In general all of the above campaign experiences gave very satisfactory evidence of the motor's ability to meet the average conditions of hauling in so far as the main routes are concerned. Except in the case of the front in France, the general experience was that animal-drawn transport had to be relied upon for hauling in the areas off the main or best routes. In our own country, where only about four per cent of the roads are rated as good enough to carry motor truck freight routes we will have to be guided by the lessons learned on the fronts outside of France. Even so, the facts indicate the happy conclusion that we shall be able now to spare the horse a considerable amount of the dreadful toil and drudgery of hauling supplies. Freed from this duty, his development will turn noticeably to the saddle class and he will be able to meet even more satisfactorily his duties as a mount for the trooper in battle and in the activities of scouting.

Now as to the question of transportation in the areas off the main supply routes. An army deployed, that is to say extended to present its fighting front to the enemy, has to accommodate itself to those features of the land—elevations and depressions—which will give it the maximum advantage over the enemy. But these likewise frequently include great disadvantages in the matter of hauling supplies to the troops, and it is in this phase that the motor has thus far failed to prove itself sufficiently reliable to supplant the horse and the mule. The infantry, cavalry and artillery while actually engaged with the enemy frequently have to demand the placing of vehicles, for their protection and accessibility, in positions where the irregularities of the surface are beyond the power of the motor-propelled vehicle to negotiate.

The War Department has made very extensive tests to determine the extent to which army transportation can safely be motorized. In the matter of any favorable development, such as the advent of the motor, patiently developed proof is the only safeguard as between the zealot on the one hand who clamors hotly for immediate and complete motorization of all transportation and the over-conservative type who is reluctant to release horse and mule drawn transport on the ground that this agency always has proved reliable. The former forgets that war will be fought as a rule in regions of bad roads or of no roads at all; the latter overlooks the fact that on favorable terrain the motor is reliable and we must avail ourselves of its greater speed and carrying capacity. Then, too, these tests are essential to show the civilian mechanical expert how much more rigorous are the demands of wartime transportation as compared with the necessities of motor freighting in time of peace.

For some years before the World War the Government tried out motor trucks in long marches, one of which was across the continent. Then came the extensive test actually with troops in the expedition of 1916 into Mexico. On the great motor roads of France our own trucks demonstrated what wonderful results could be attained when circumstances were most favorable under war conditions. Following the war, extensive tests were conducted by the army in all parts of our own country. Some of these tests are continuing at the present time and obviously will continue in order that we may receive the advantage of every new development.

An interesting and comprehensive try-out was conducted during November, 1919, in Arizona, where conditions gave lessons as to what might be expected in a terrain where certain stretches of sandy roads presented formidable obstacles. Three days of rain during the march rendered other roads slippery and soft. Arroyos with difficult crossings were encountered. One hundred motor vehicles of all sorts were employed and 260 miles were covered in 18 days; including four days that were spent in making tests in muddy fields, awaiting spare parts for repairs and, apparently, on one occasion, because the roads were slippery. Five-ton tractors, 3-ton trucks, 1½-ton trucks, and ¾-ton trucks participated in the test.

In reviewing all the circumstances of this test and the results achieved, the following official opinion was expressed: "It is clear * * * that 3-ton trucks cannot, in all sorts of weather, negotiate any and all places wagons can pass through, both loaded to capacity and unassisted; or assisted only by the power belonging to a neighboring vehicle of the same sort in its own train. When loads are removed to allow pulling of vehicles out of mud greater relative relief is afforded the wagon, because its load forms a larger percentage of the total gross weight. It is believed that a truck train, either of 1½-ton trucks or of 3-ton trucks, assisted by a tractor or tractors, can travel any road a wagon train can negotiate, but that if a road is continuously bad so as to cause the frequent use of the tractor, the wagon train will make better time for a limited period, such as a day's march. There is no doubt * * * that well trained pack trains are still needed with all cavalry regiments and that * * * the development of the motor transport has not reached the point where wagons can be entirely dispensed with by all of the cavalry."

In commenting on this test and on the above opinion, one of our most experienced officers of high rank said: "Reading

of the report convinces me that, while motors can be of great use to the cavalry, the day for complete motorization of cavalry commands, regardless of climate, terrain and roads, has not arrived. * * * As at present advised, I believe that all regimental transportation for cavalry serving in this region * * * should be animal drawn; but that when roads are available, supplies should be delivered by a reserve of motor transportation from the rail-head, or other advanced base, to the regiments. When the line of communications attains a length of two or three days' march, motor transportation would be a great factor in maintaining the fitness of the animal-drawn transportation of the cavalry commands. The availability of motor transportation would enhance the mobility of cavalry enormously in a country with a good network of roads. The case is readily conceivable where cavalry would go ahead with motor transportation leaving its wagon trains to follow by slow stages.* A combination of animal-drawn transportation and motor transportation would provide a flexibility and adaptability to various conditions of climate and terrain heretofore not available to cavalry commands. For example, in the policing of large areas where there are no railroads, motor transportation will be indispensable."

Preparing the Road for Motor Trucks

Motor Convoy in Winter Test

Another important test was conducted by the 1st Cavalry Regiment at and in the vicinity of Douglas, Arizona, between January 1, 1920, and March 31, 1920, the motor vehicles employed being two 5-passenger touring cars, eighteen ¾-ton trucks, twenty-one 1½-ton trucks, three tankers, eighteen 3-ton trucks and one 5-ton tractor. This train consisted of the available vehicles at hand and was not suitable, as a whole, to accompanying cavalry. The regiment turned in all its draught animals and vehicles on January 1, 1920. During the subsequent period of 91 days the motor trucks accomplished all garrison service, all service of supply and served the regiment on a march of 337 miles over varied terrain. Throughout the entire period the weather was favorable for motor service. The conclusion was that "the test had been of great value but not conclusive. Weather and roads are the deciding factors in arriving at a decision as to whether or not cavalry trains should be motorized and furnished with equipment of types now developed." It was recommended that the test be continued.

From April 1, 1920, to June 30, 1920, the 1st Cavalry carried on a further try-out, using practically the same number and class of motor vehicles. All garrison hauling was performed by motor transportation. Two marches were made, aggregating 573 miles in 20 days, using five 1½-ton trucks and one ¾-ton truck for supplies. It was stated that for garrison service the motor transportation had served admirably, the conditions being practically ideal, there having been no rain and the roads being asphalt or improved dirt roads. On the two marches all trucks got through to their destination with occasional mishaps. The reports show that the roads were dry and state that certain sectors would have been impassable for trucks in wet weather.

In the spring and summer of 1921 important and especially interesting tests were carried out in Vermont by Cavalry troops and in Minnesota by the Infantry. In both these regions deep snows and very low temperatures presented serious conditions for motor transportation.

The Vermont test was carried on at Fort Ethan Allen and in that vicinity. Prior to this the operating personnel had been sent to the Motor Transport School at Camp Holabird for an eight weeks' course. In addition to a few motor cycles, the vehicles for this try-out included two 5-ton tractors, seventeen "cargo trucks," ten "combat trucks," two ambulance trucks, two light repair trucks, ten kitchen trailers, ten 300-gallon water trailers, ten 3-ton trailers, ten 1½-ton trailers, one 10-ton trailer, one 2½-ton tractor, one 1½-ton tractor and one repair truck.

It was satisfactorily demonstrated that all the garrison hauling of supplies, including hay and grain, the removal of manure, ashes and the like could be done much more economically by motor trucks than by animal-drawn transportation. The roads in and about the garrison are well metaled and the test was equivalent to ordinary city hauling in most respects.

In February a road test was made under severe conditions, the thermometer going as low as 19 degrees below zero at one time and being below freezing for twenty hours at a time. The roads were covered with snow ranging from 6 to 20 inches on the level, which drifted in the hills to a depth of two to three feet. Under the packed snow, on the outward march, the roads presented a sheet of solid ice. During the return, the snow almost disappeared leaving the roads icy underneath with running water and slush on top. Much hilly country was traversed. The convoy included, in addition to motor cycles, one touring car; one ¾-ton repair truck, pneumatic tired; fifteen 1½ and 2-ton trucks (eight were pneumatic tired); two class "B," 3-ton trucks, solid tired; 1 motor ambulance; five 4-wheeled, 1½-ton, tank

*As a matter of fact the World War had furnished some fine examples of this use of motor transportation. For example, during March, 1918, in Mesopotamia, Maj. Gen. Brooking's "Euphrates Force," attacking the Turkish Euphrates force some 75 miles west of Bagdad, drew the enemy into a spirited and stubborn engagement among the hills of Khan Baghdadi. Brig. Gen. Cassels taking the British 11th Cavalry Brigade far around the Turkish right got on his only line of retreat—the Aleppo road—the final result being the capture of an entire Turkish Division. The 11th Cavalry Brigade was accompanied by a train of small cars carrying all supplies. While there were no roads, the region traversed was so level and free from obstacles that these cars could follow the cavalry very well. On several other occasions Brig. Gen. Cassels' brigade was successfully supplied by a train of small cars in operation during the dry season.

trailers, solid tired; five 2-wheeled kitchen trailers, solid tired, and one 5-ton tractor.

Solid tires were found useless in snow and ice on the hills. No trouble of any kind developed in the pneumatic tires during this three days' test.

The 5-ton tractor was found unsuited to snow and ice conditions in the hill country. Lubrication of the tractor track was difficult in snow as the latter absorbed the oil, like ink in blotting paper. More than one trailer to a truck or tractor was found impracticable because of skidding on hills and creeping on curves. The water tanks froze solid,

A Big Truck in Trouble

thus cutting off the water supply. During the time of lowest temperature motors had to be kept running during short halts and they were run periodically during the night to prevent freezing. Even so, the tractor's radiator froze while running. No confidence could be placed in anti-freezing mixtures. This test was severe and many motor disadvantages were in evidence, but those who participated were, in general, optimistic and desired a further test under similar conditions.

A second test in the mud, snow and ice of New England roads was conducted March 8 to 15, 1921, with ten 1½ and 2-ton trucks, pneumatic tired; two light repair trucks; one motor ambulance; one touring car; one 1½-ton tractor and two motor cycles. In addition to the above, six trailers were towed with great difficulty during part of the first day but all except one were on that day left at one of the towns en route. Mud 1½ feet deep was encountered in one region, the road was frozen and hard in another, grades were at times excessive and on some stretches the snow varied from one to five feet in depth on the road and in the side ditches up to seven feet. It was found necessary to use loose hay and cordwood on the snow to prevent the wheels sinking in too deeply, much digging and shoveling was done, and at times the convoy cut across fields in preference to running on the roads. The trucks averaged 2-9/10 miles to the gallon. About 154 miles were traveled at an average of 22 miles per day. The temperature varied between 60 and 8 above zero. A heavy rain and later a thick snowstorm were encountered. The convoy was delayed by mud, snow and ice conditions and by breakage resulting from rough work. One officer who participated in the test believed the achievement a creditable one for the motors and that cavalry troops marching under the same conditions would not have outmarched the convoy. That the trucks only made 5 miles one day, 4 miles the next day and 3 the next was attributed to the lack of highly trained personnel experienced in these special conditions.

During the spring of 1921 two more tests were made by the Fort Ethan Allan convoy. Much mud was encountered. The pneumatic-tired trucks performed excellently but the solid tires did not do so well. The trucks averaged about 5.4 miles per gallon of gasoline.

The concensus of opinion among the senior officers who considered all the facts brought out by these tests was that cavalry regimental trains should not be composed of motor trucks, due to the fact that trucks can not do all that trains are required to do on poor roads, in mud, in fields off the road and in mountain country over trails where frequently pack transportation is necessary. There appeared to be nothing in the tests that would actually justify the replacing of the animal-drawn transportation of the cavalry regimental train by the motor equipment used in the test.

The Minnesota test conducted at and in the vicinity of Fort Snelling included tractors of various weights, trucks of all sizes, tankers, trailers and ambulances in much the same proportion as in the New England tests. This was a try-out to determine particularly the usefulness of motor transportation as a part of the infantry regimental train. The report on the test stated that trucks were unable to negotiate the deep snows of Minnesota unless other vehicles had broken a good trail: it was added that the snows of the winter in question had not been as deep as usual nor had the temperature been as low. It was found that the tractors could not get traction in the snow. "Neither the auto trucks nor the caterpillar tractors were able to place rolling kitchens and ammunition wagons in the ravines and other sheltered places required by the tactical dispositions of infantry troops. * * * Both on the roads and cross country, animal-drawn transportation will serve the infantry needs better under conditions of ice and snow." As to mud and water it was concluded that, "In the spring, or after any protracted rain, the auto trucks are useless except on hard roads."

From all of the above tests and the fact that considerable motor transportation is in daily use by troops at our vari-

Man Power to the Rescue

ous garrisons and camps it will be seen how thoroughly the War Department has gone into this matter. From the standpoint of the cavalry especially it is hoped that a motor equipment can be developed which will function with certainty, in company with cavalry regiments, over all kinds of roads and country and during all seasons, without being especially dependent upon highly trained mechanicians and drivers.

It is not difficult to decide the question as to how we should take advantage of the excellent motor equipment already developed and fully equal to all hauling proposi-

tions on good roads under average weather conditions. Army headquarters and Corps headquarters should be centers for motor pools comprising freight-carrying trucks of all desirable capacities. In a country which has in operation over ten million automobiles of all kinds, the possibilities of mobilization are apparent. The commander-in-chief of any expedition, clothed with authority to handle his organization throughout on the principle of elasticity, can decide the tasks of motor transportation and the necessary allotments of vehicles, according to the terrain and climate.

In all the tests conducted thus far it has been noticed how the motor appealed to the enthusiasm of the personnel conducting the tests. Invariably great zeal was aroused and much energy was freely devoted to the surmounting of obstacles. In each case the motor received the maximum human aid, so that it has not suffered in any of its try-outs from indifference.

Those who have believed that all army transportation could be motorized, thus relieving the horse and mule of this drudgery, and those who have felt that the day of the horse had passed as a battle charger have erred in a very human manner: they have not actually gone far enough into all the facts of the World War but have reached conclusions as a result of some of the facts. It is exactly so in the case of those who believe that the airplane as a scouting agency has rendered the horse unnecessary. The facts are that the airplane by its superior ability to discover large and conspicuous enemy formations and installations at a greater distance, is of great assistance to the horse, conserves the strength of the latter for accurately directed missions and makes him more valuable than ever as a combat agency.

Smooth Sailing

The airplane can not fly in all kinds of weather. Storms, fogs, mists, and night render aerial observation of little effect. Forests, towns, villages and even the irregularities of a desert terrain afford hiding places for those who would escape aerial observation. On the other hand the soldier on horseback moves forward, when necessary even in storms or at night, scrutinizing the country at close range. He cannot be eluded.

The airplane operates to relieve the cavalry of distant or strategic reconnaissance to a large extent and to assist and confirm in the matter of tactical reconnaissance. Especially important is the aerial strategic reconnaissance because when it is successful in discovering considerable bodies of the enemy force the cavalry can get into contact with such force by very direct marches thus obviating the great fatigue and waste of horses heretofore attending the cavalry's unassisted search for the enemy. As Field Marshal Allenby has so aptly remarked: "The battle value of cavalry increases with the breadth of vision bestowed by aircraft. The Air Service, by enlarging the horizon, renders possible such bold strokes by masses of horsemen as were seen in Mesopotamia, Palestine and Syria."

The horsemen of our army must always be prepared, however, to search for the enemy even in his distant approaches, because this cannot safely be left to observation from the air when the opposing armies are operating in normal or movement warfare. There were some striking examples of this during the World War.

On the Macedonian front in 1916 when General Sarrail moved his army out from the lines around Saloniki and established his force on a front some one hundred miles in length, he replaced the rejuvinated Serbian army on his left. The Bulgars and Germans anxious to injure the morale of the Serbian army by a decisive blow concentrated some 30,000 troops against the latter. Marching their troops along the by-ways, taking cover by day in the towns and woods and moving forward by night the Central Powers attacked the Serbian front by surprise and forced the Serbs back twenty miles before they were stopped. The allied air service, enterprising and well commanded, had not discovered the extent of the enemy concentration.

Oddly enough, General Sarrail, in September of the same year, moved three divisions to his own left and, in turn, eluding aerial reconnaissance, attacked the Bulgar right by surprise, continuing his advantage during the succeeding weeks until he effected an advance of 60 miles and captured Monastir. He, too, marched his troops along sheltered roads, taking advantage of the broken terrain and the woods and villages of western Macedonia.

The Turks in advancing against the Suez Canal in 1916 for the attack which they delivered at Romani in August of that year succeeded in avoiding the British aerial reconnaissance in a remarkable manner, considering that they had to move through a treeless, desert country whose towns and villages were few and far between. Their force numbered about 16,000 men who, marching from near Beersheba, covered 120 miles in 10 days before their presence was discovered about 30 miles from the British front lines by the air reconnaissance. During their long march they had hidden by day in the deep shade under the steep banks of the innumerable "wadis" or dry arroyos of the rocky country, and in the desert itself they had scattered among the sand dunes.

So in the field of scouting and reconnaissance there will be not only work which the horseman alone can do, but, as always, more than he can do by his utmost efforts.

The great thing that the motor has accomplished—and it will do more along the same line—is to release the horse from the killing drudgery of hauling the great bulk of supplies. This appears likewise in civil activity where the horse is now spared much of the heavy hauling.

It is interesting to note that coincident with this relief from a large amount of draught work the horse is becoming more and more popular as a saddle animal. There is a noticeable increase in popular interest in horseback riding in many of our cities. In the army, riding is being taken up more and more by officers who do not actually belong to the mounted services. The infantry, engineers and others are joining more and more in mounted sports and are feeling also the advisability of having more of their officers actually mounted in order that they may more effectively accomplish their professional tasks. Everything considered, it would seem that the motor has come not to eliminate the horse or the man from the battlefield but merely to enlarge his usefulness and spare him some of the drudgery.

Panoramic View of Old

The Chemical Industry

Its Relation to National Defense

By

J. MAYHEW WAINWRIGHT
Assistant Secretary of War

[Hon. J. Mayhew Wainwright, the Assistant Secretary of War, delivered the following address upon the occasion of the opening of the eighth "National Exposition of Chemical Industries" in New York City on September 11th. His remarks are of especial interest to the readers of ARMY ORDNANCE, expressing as they do his opinion of the importance of industrial preparedness.—ED.]

IT is a pleasure for me to address you on "The Relations of the Chemical Industry to National Defense," for without the Chemical Industry this nation would be practically helpless in a war of any magnitude.

The World War taught us "No end of a lesson." In it we discovered that entire nations, not merely armies, fought; that all young men had to be called to the colors; that the older men had to work at home to supply them; that our industries had to be mobilized and organized for war; and that even many essential war supplies were not produced in our country in a sufficient degree to protect us in time of conflict. We were pitifully unprepared. Our army did not spring to arms overnight. Nine months were required to train our citizens to be soldiers. The training of an officer, we discovered, was a matter of years. Our industries could not be organized for maximum war production and essential matériels delivered to France in any quantities until the Armistice was signed—a year and one half after the declaration of war. Ours was the humiliation of asking our allies to hold back the enemy for a year while we mobilized our man-power. We had to beg them to sell us matériel for two years while we mobilized our industries. Everything we needed for war—soldiers, ammunition, guns, ships—we lacked. Costs tripled and quadrupled as our frantic efforts continued until our national debt reached the staggering figure of $24,000,000,000. We did perform wonders and accomplished a remarkable achievement almost unprecedented in the annals of history, but at what a frightful cost.

Our country must never be confronted with such a crisis again. Whatever is needed for military operations must never be left at the mercy of a foreign power or of a benign providence. That is why our patriotic young men were in training camps this summer. That is why we are also making similar defense plans for our industries. That is what the Vice-President had in mind, no doubt, when he said, in the course of his speech at Portland, Ore., last month: "As a broad principle, protection has meant in the first place an adequate national defense. A recent very painful experience demonstrated that many of the essential war supplies were not produced in our own country in a sufficient degree to protect us in time of conflict. That condition must never arise again."

As Assistant Secretary of War I am charged by law with the "supervision of procurement of all military supplies and all other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of matériel and industrial organizations to wartime needs." This responsibility makes the "relations of the Chemical Industry to National Defense" of paramount interest to me.

The requirements of the War Department in time of war for matériel produced directly or indirectly by the Chemical Industry of this country are stupendous in size and multitudinous in range. We require paints for all Bureaus of the War Department, gasoline and greases for transportation and automotive vehicles, lubricating oil and graphite for bearings, "dopes" for airplane cloth, dyes for uniforms, many food products made usable by the Chemical Industry, artificial leather, artificial silk, medicines, explosives and propellants for munitions, and many other matériels. Therefore it can be stated that practically every Bureau of the War Department is dependent upon the Chemical Industry in time of war—the Medical Industry for medicines, the Quartermaster Corps for gasoline, oils, graphite, greases, dyes and other things; the Air Service for protective coatings for airplane wings, the Signal Corps for certain electric supplies, the Ordnance Department for propellants and explosives, the Chemical Warfare Service for smoke gases and other smoke-producing materials, and so on down the line. Nor does the contribution of a chemical industry end there. Without modern sanitation the diseases that limited the size of armies and duration of campaigns in in the past would still rule. Without increased fertility of our fields we would not have the necessary foodstuffs due to the reduction of man-power for farming purposes. Without inventive genius we could not take advantage of the new scientific developments made necessary by every war.

In ancient warfare chemicals played a very small part, as men fought with their hands, clubs, rocks or any other available missile. As civilization developed the Chemical Industry likewise developed and in the Middle Ages the dis-

Hickory Powder Plant in 1918

covery of gunpowder made the Chemical Industry vital to war. Later, the discovery of high explosives and other chemicals, such as bursting charges of projectiles, has still further emphasized the importance of the chemical side of warfare, each nation at war utilizing from time to time new destructive agents, products of the chemical world, each in turn being more destructive or more difficult to guard against.

There has been a popular use in the last few years of the term "Chemical Warfare" as pertaining solely to the use of poison gases and other gaseous materials. Practically all modern warfare is "chemical warfare." Chemistry is just as seriously involved in high explosives ammunition in shrapnel and in high explosive drop bombs as it is in poison gas. The manufacture of smokeless powder and high explosives, of which hundreds of millions of pounds are used in a year in modern warfare, are chemical processes involving chemically educated people, chemical facilities and chemical principles.

In fact the most important contribution of the Chemical Industry is its contribution toward the supply of munitions, and, therefore, I shall touch more fully upon that particular phase than any other. We have had it impressed upon us by the last war that munitions are the controlling factor in exerting a nation's maximum effort in combat. Man-power can be mobilized and trained and placed in the field almost a year before the necessary munitions can be manufactured and supplied to them. Therefore, it becomes of paramount importance to the War Department to utilize every industry to assist in expediting munitions production.

It is interesting to note that during the World War ammunition represented one-half of the expenditure for munitions, and that fifteen cents out of every dollar spent by the Government was for ammunition, and that at least one-half of the expenditures for ammunitions were for materials such as propellants, explosives, gases, etc., which were supplied by the Chemical Industry of the country. It supplies the propellant to throw the projectile and the filler for the projectile which, upon detonation, supplies the energy and destructive force which makes the modern projectile such a devastating instrument.

To a large extent, munitions are special in nature and not comparable to commercial peace-time producton in general. While uniforms, food, shoes, bedding and other materials necessary for the maintenance and welfare of an individual are the same in time of war as in time of peace, munitions, which are the controlling factor in the utilization of a nation's energies in war, are not comparable to peace-time material. On the other hand, in time of war the nation's industries must be diverted from their normal production methods and materials. I emphasize this to show how important it is in time of war for the Government to be able to depend on the industries to assist in such times of stress. The Government leans very heavily upon the Chemical Industry, because it realizes that from the Chemical Industry it must recruit its personnel and facilities for manufacture, in order to produce the chemical components of the vast quantities of ammunition which are necessary to successfully prosecute a modern war. The more trained chemists we have in the varied lines of industry, the more chemists there will be available for war use. The highly trained chemist like the highly trained man in any other walks of life, can take up a slightly different class of work in an emergency very readily, but he can not be made by magic. He must be trained in time of peace.

America is naturally a peace-loving nation, a nation which after any war is prone to forget the lessons of that war, a nation that drifts back into a false sense of security, and forgets Washington's admonition to "prepare for war in time of peace." The country naturally is more interested in its agricultural pursuits, its commercial affairs and other activities which are close to the hearts of each individual, and views with irritation and annoyance any demands upon its pocketbook in the form of taxes to maintain an army or navy or to produce and keep in first-class condition a reserve of munitions or in any way to stimulate among commercial concerns an interest in munitions production, or the methods and facilities necessary to produce munitions. The unthinking man would even like to prohibit a commercial concern talking about munitions and limit munitions manufacture to Government plants only. At the present time our Government arsenals and navy yards are to a large extent idle, the organizations are broken up and only the slenderest nucleus is maintained.

If our own facilities are idle, if our own organizations are dissipated in time of peace, and, moreover, if our own facilities are only a drop in the bucket, then somebody has to help us out in time of war. As one of our greatest needs is chemical ammunition, it is obvious that the Chemical Industry is most vital to this country as a prop upon which to lean at the outbreak of a war. We would take your plants, we would take your personnel, we would take your experience, we would take your patents, we would take everything you have, because we would have to have it to produce the munitions of war, which, as is evident, are tending more and more to chemical ammunitions.

I will speak for a moment as to the semi-technical phases of the relations between chemistry and war. In ammunition we have to have propellants. At the present time we use smokeless powder, which is a nitro-cellulose product, using cotton, nitric acid, sulphuric acid and alcohol. In high explosives, we have TNT, which is nitrated tolnol; picric acid, which is nitrated benzol; tetryl, which is nitrated analine; nearly all products of coal. All these processes were developed by the Chemical Industry and in time of war would be manned by the Chemical Industry. What chemistry can do is best illustrated by the multitudinous resources discovered in our everyday friend, coal. From it we get a large proportion of things required by man. With coal we cook our food; with coal gas we light our houses; we get fuel to run our power plants; we get tar with which to build our roads; we get lubricating oil; we get coke for our fur-

naces; we get pitch for paints, insulations, roofs, etc. We get graphite for pencils, electrodes for electric supplies; explosives with which to injure a man; laughing gas with which to put him out of his pain and drugs with which to cure him. We get dyestuffs to color our clothes. We get saccharine with which to sweeten our coffee in time of war; perfumes for our ladies; artificial silk with which to clothe ourselves—all from dirty, smutty coal which we see in the coal bin every day. I am convinced that your industry will discover even greater uses for coal and still more by-products of inestimable value in an emergency when the life of the Nation is at stake.

The American is an ingenious soul and is constantly striving to find something in nature's vast realm that is of benefit to mankind and that likewise benefits the man that discovers it. The Chemical Industry is now delving into more intricacies of the chemical world, testing and trying to find new useful chemical compounds, and in this way it may discover explosives far more powerful than any known at this time, propellants which will be more efficient than those we now have; new gases which will be not poisonous to mankind but which will temporarily disable him with no harmful after effect, and all this will rebound to the benefit of the Government.

TNT was discovered by the Chemical Industry—picric acid was discovered by the Chemical Industry; smokeless powder was discovered by the Chemical Industry; black powder was discovered by the Chemical Industry. Every explosive or propellant we have was discovered by the Chemical Industry. It is true that military chemists were working on these same problems, but I am considering them as a part of the far larger class of the Chemical Industry.

It is of obvious advantage to the Government to encourage the Chemical Industry to carry on researches and to encourage the Chemical Industry to include in their researches those materials which would have a definite military value.

Our own Government chemical experts are working on these problems, but, in view of the necessarily limited funds available, we must depend also on the Chemical Industry at large.

In considering the relation of the Chemical Industry to national defense, the most outstanding example that comes to one's mind is the tremendous advantage derived by the German Government from the fortunate position it found itself in at the outbreak of war, by having the most powerful and most efficient chemical industry that existed in the world. Without the German Chemical Industry, the Germans could not have carried on the war for one-half of its duration. She was shut off from outside resources, shut off from the Chilean nitrate supplies, shut off from the American markets; she had to be self-sustaining. The German Chemical Industry by its pre-war researches and the ramifications of its investigations, was able to suggest to the government substitutes for these chemicals or raw materials pertaining to chemistry which had previously been imported. The German Chemical Industry had perfected the Haber process of nitrogen fixation from the air, which process during the war was extended and expanded to the point where it practically took care of all the requirements of the German army. When this country was plunged into war, if the Chilean nitrate supply had been cut off, we could not have produced ammunition. When the German government, due to scarcity of raw materials, found itself hampered by the lack of any particular raw material for explosives, their Chemical Industry had perfected and had available for them a substitute explosive, thereby relieving the situation. When wool and cotton became exhausted, the German Chemical Industry was able to substitute wood pulp which could satisfactorily solve this shortage. When hemp became exhausted paper was substituted for making rope. When food became short the Chemical Industry was able to scientifically advise the nation as to the best manner of conserving the existing foods and as to substitutes that could be utilized with just as beneficial an effect.

During the last few months we have heard a great deal of the dye industry, which is one of the important phases of the Chemical Industry. The dye industry is closely related to the explosives industry. In time of peace, a powerful dye industry in this country becomes at once a powerful instrument of preparedness for war.

In munitions production two great industries are primarily involved, the metals industry and the chemical industry. The metals industry gives us our guns and projectiles, and the chemical industry gives us our explosives and propellants. These in general constitute munitions.

Being charged as I am by law with the responsibility for making adequate provision for the mobilization of matériel and industrial organizations essential to wartime needs, I have taken certain steps which may be interesting to briefly describe to you. The War Department exists in time of peace largely for providing for the defense of the country in time of need. Therefore, it is necessary in time of peace to make plans for war. I am, therefore, giving a great deal of attention to planning how to utilize the commercial industries of the country to best advantage in time of war. The basis of any war plan is naturally the size of the army to be maintained. Therefore, the requirements for matériel are computed upon the basis of the size of the army required. The matériel problem resolves itself into two phases: first, what is required, and, second, how is it to be produced? Having determined what is required in the various Bureaus of the War Department, the commercial industries of the country must be analyzed in order to allocate to each its share of the needed production. I have established in my office a small organization charged with the duty of supervising and coordinating for the War Department the industrial plans of all the Bureaus. Each of the Bureaus, such as the Medical Department, has its own industrial war planning unit which, under supervision of the organization in my office, computes its requirements based on the approved program, and estimates the production needed to meet these requirements. The various industries will undoubtedly be acquainted at a later time with the requirements in general and be asked to state to what extent they can contribute production to meet these requirements. In other words, there will have to be made by the War Department an industrial survey and a tentative assignment to the various industries of their share in the nation's war production. We will try to bother you as little as possible, try to ask all our questions at one time, and try to present the matter in an understandable way, but we must ask your indulgence and help in this work. It would be of no avail to make plans for war that were not based on knowledge of conditions in the various industries.

You should know that we fully realize the importance of the Chemical Industry to national defense, that the War Department appreciates its dependence upon the Chemical Industry, and to ask your cooperation in fostering close relations between the Chemical Industry and the various Bureaus of the War Department, which deal with munitions, in order that in time of peace adequate plans can be perfected to utilize in time of war the tremendous potentialities of the Chemical Industries as one of the strong arms of the national defense.

Ordnance Work with the British Army

In Macedonia and Mesopotamia

By

Colonel R. H. McVITTIE, C. M.G., D. S. O.
Royal Army Ordnance Corps

[ARMY ORDNANCE is fortunate in being able to present to its readers an account of the Ordnance work of the British Armies in Macedonia during 1915-16-17 and in Mesopotamia during 1918. The account was prepared by Colonel R. H. McVittie, C. M. G., D. S. O., Chief Ordnance Officer of the British Armies first in Macedonia and later on in Mesopotamia—who, at the present time, holds the same position with the British forces in Ireland. Experienced in his line of work, of rugged physique and of forceful personality, Colonel McVittie was splendidly equipped to meet the difficult problems presented by the Near East and Middle Eastern fronts. Far from sources of supply, in regions of poor roads or no roads at all, where railroads and wharves had largely to be built or extended and where mechanical appliances had, in many cases, to be improvised out of the crudest materials, the ordnance work of the British Armies as seen in the Salonica and Baghdad Areas was one of the most difficult supply achievements of the War. British Ordnance is of wider scope than our own, in that it is charged not only with the supply of guns, ammunition and appurtenant equipment but with the supply of wagons, clothes, tentage, implements, cooking utensils, soaps, oils and grease, tools, timber, telephones and other signal equipment, harness, saddlery and, in fact, all the great essentials of an army's equipment and the repair of same.—ED.]

THOSE who are responsible for the supply of munitions of war to the British Army are faced, more often than not, with the problem of how to carry out the work in a more or less uncivilized country.

Such a problem calls for initiative. The best of regulations fail to cope with the situation and the man on the spot has to choose between riding roughshod over regulations, which he has been taught to regard as the "Laws of the Medes and Persians," or get himself broken for following them when his common sense tells him that to do so will result in disaster.

Success is the only guarantee for him. So, armed only with that invincible spirit of hope which is the heritage of the Anglo-Saxon and which his training at school and college do so much to foster, he sets off to do his bit firmly convinced that all will be well.

On arrival at Saloniki the Royal Army Ordnance Corps found themselves up against it from the start. Ships with troops and stores were pouring in, the dock and wharf accommodations were hopelessly inadequate, the Greek authorities were out to put every difficulty in the way and the weather conditions were as bad as could be. A site was selected for an Ordnance Dump, which can at once be allowed as having been a bad one. There is a golden rule about selecting a site for an Ordnance Depot, and it is: Choose a place far bigger than you think you can ever need and then double it. Then you may hope your depot will eventually be large enough, and you will not have to shift the whole of your stores, as you otherwise certainly will, just at the very time when a "strafe" is on.

The depot finally selected was actually the third choice, and most of the losses which followed the disembarkation were due to the initial bad selections. One knows, of course, that there are times and places where no choice is given and one has to make the best of a bad job, but when such is not the case, the Chief Ordnance Officer must think big and be prepared to act up to his thought. The Saloniki depot was about five kilometers out from Saloniki on the Monastir road. A rail siding was run off the main line to Sofia, thus giving us both road and rail for receipts and issues—and one way or another the motor roads came.

The next thing was to get storehouses. The store tent is a most useful and necessary thing in the early stage of a campaign, but it is very wasteful of room and requires more staff; also it is very dangerous in the case with which it catches fire. A spark and a high wind, and the whole depot may "go west!"

The inhabitant, be he white, yellow, brown or black, is invariably a cigarette smoker, and the cigarette end rapidly thrown out of sight to prevent the smoker being caught is more dangerous than the match used to light it; one day, sooner or later, a fire will be started. Fire orders are thus one of the earliest sets of orders to be got out, and not until these have been thoroughly tested can the Chief Ordnance Officer breathe freely, though even then, as the following incident will show, the human element needs to be considered. The Director on one occasion paid a surprise visit to the depot, and ordered the fire alarm to be sounded. This was done and the Chief Ordnance Officer prepared to receive the commendations of his chief, who stood, watch in hand, to check the time. His rage may be imagined when he saw all ranks pouring out of offices, workshops and storehouses with pallid faces turned to the sky, a fire alarm the last thing in their thoughts, and heard the Chief's sarcastic remark that he supposed they were expecting the fire to come down from heaven. What had caused the trouble was the fact that on the two previous days "Richthofen's Circus," one of the Boche star turns, had visited the depot by way of a trial run before bombing London. Everyone's mind was full of bombs and such like troubles, hence the absentmindedness. But this was not the worst, for when the fire alarm had got in full blast no water came through the hose, and it was found that the main supply stop-cock was rusted and could not be turned. Storehouses mostly 400 feet by 50 feet were obtained and run up quickly, and not till then could the Chief Ordnance Officer dismiss the nightmare of fire which pursued him if ever he left the depot.

The list of stores for an army as laid down by the British authorities is divided into some 30 sections and these are grouped together to form some 8 groups. In the Saloniki depot each of these groups was a self-contained little depot; the work in each group, as far as issue, receipt and accounting, was identical, thus allowing for casualties in a group being filled by men from another who would thus be familiar with the procedure. Above all the groups and in personal touch with them sat the Chief Ordnance Officer with his staff. These consisted of the following branches:

(1) Indent branch which received all demands for stores, passed out the data for issue to the groups, and carried out the necessary correspondence with the units.

(2) Provision branch which dealt with the stocks held in the depot and was responsible that they were kept up to requisite high-water mark—a very worrying job when you can not guarantee that your incoming supplies may not go to the bottom of the sea and, if the troops run short, you might as well be with the stores.

(3) Issue branch which made all arrangements to collect the stores from the groups and deliver to the unit.

(4) Receipt branch which made all arrangements for the receipt of stores both from the overseas bases and the troops and distributed them to the various groups.

Such is a brief outline of the administration of the Saloniki depot.

The test of efficiency in any depot is that all the wheels of the machine run smoothly and no matter what calls are made on it, it is never defeated. In war, however, more is required than the best and here is where the personal element comes in. Among the officers and men who joined from civilian life were many whose personal push and brains had brought them success in the business world. These men were all out to improve where possible the military machine, by the introduction of ideas which had led to their own success in pre-war days.

One of the heaviest financial drains on the British Saloniki Force came through the wastage of clothing, blankets and equipment generally. For instance, to enable the large number of blankets—some 600,000—to be disinfected, washed and repaired during the summer months so as to be ready for reissue in the winter, they had to be sent to Alexandria, and the expense thus incurred needs no explanation.

Among the temporary officers were two men, Dailly and Brown, the former being an important member of one of Canada's greatest firms, while the latter was managing director to one of the leading cloth firms in Scotland. These two put their heads together, with the result that a large disinfecting, washing and repairing business was started, organized and brought to such a state of perfection that the very smallest item in the mass of returned material was salved and made fit for reissue, the financial saving running to hundreds of thousands of pounds sterling per annum. When one considers the material with which this was done, practically all the plant made locally, and 90 per cent of the labor being Macedonian women and children together with Bulgar prisoners, the result was little short of marvelous.

The manufacture of soap from food refuse was an idea born of the necessity of cutting down freight, either by local purchase or manufacture. This idea resulted in a soap factory turning out 80 tons of soap per month, of a quality rivaling the best produced by commercial firms, and from which 23 tons of glycerine were sent home to England. The saving in tonnage alone amounted to 1,300 tons and the financial gain on the factory amounted to £36,000, and the cost of the entire plant, estimated at £3,000, was covered by the profit on the first three months working.

The above is only a short sketch of some of the work done in the Ordnance Depot of the British Saloniki force, but it would be incomplete if no mention were made of the workshops. These started with only such machinery as was with the ordnance mobile workshops in the field, yet within an incredibly short space of time sheds had been erected, up-to-date machinery installed, the whole depot lighted by electric light and the place humming like a veritable hive of industry, while the boot repairing shop was turning out 8,000 pairs of boots as good as new from the heap of apparently useless boots which came back from the front and which otherwise would have had to be sold at about a penny a pair.

In a country of such a rugged nature as Macedonia the wear and tear on vehicles was excessive, and with the submarine menace so bad, manufacture had to be resorted to. Here the personnel of the shops showed themselves no whit behind their brothers, for by modifications to the 18 pr. and 60 pr. equipments not only were the effective ranges increased to 8,000 and 13,000 yards, respectively, but the repairs necessary also fell off.

The greatest adverse factor with which the depot as a whole had to contend was the continual sickness due to the deadly nature of the malaria and the bitter cold which followed the heat of the summer.

In conclusion, a word may be said for the "Officers and Sisters Shop." The popularity of this innovation was not restricted to our own army; the allied armies had to be driven away from it, or they would have bought it up. When the town of Saloniki was burned the full value of the shop was felt, and the profiteering brotherhood lost many thousands. The army were out to make no more profit than would cover expenses. It made one feel proud of one's men when one saw a young fellow from one of England's proudest schools serving behind the counter and making a first-class salesman.

Mesopotamia

On this front the ordnance work was, in the earlier stages of the campaign, in the hands of the Indian Ordnance Department; when the R. A. O. C. were sent out to take charge, the Base Depot at Basra was found to be in a hopeless position, the only good point being that it was certainly on the river bank.

It could not be expanded and it was far from the men's camps, so a new position was at once fixed on and the depot shifted some four miles up stream so as to be central to the camps and with a fine sea front. On this front as time allowed, a line of jetties was built, alongside of which the largest steamers could lie and discharge over the side practically into the depot.

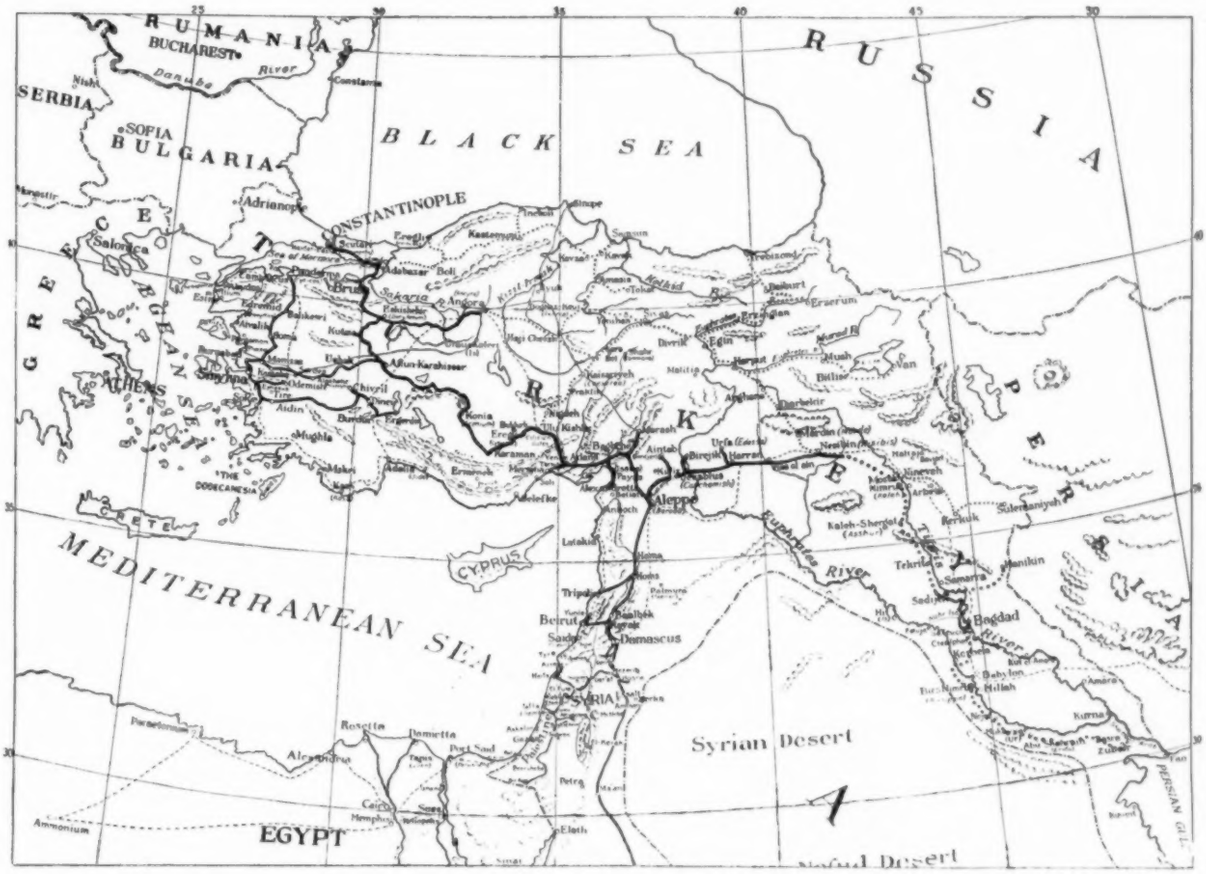
The only road then in existence ran past two sides of the depot; the story of this road is a curious one. When the troops first came to Basra there was no road at all; the old town of Basra lay back about a mile from the river front, at right angles to it and about every 300 or 400 yards a tidal creek, averaging a mile or a mile and a half in length, would enter the river; communication along the river front was entirely by native boat. It is for this reason that Basra was called "The Venice of the East." A native town is never a place to put troops in for reasons of sanitation, if for nothing else, so the camps were well to the north of the town and parallel to the river front. A road with bridges over the creeks was a necessity. Basra is only 6 feet above sea level, and at almost any time of the year if you dig a foot or so under the ground, you come to water. When rain comes, or when the river is high, the whole land is waterlogged. The road was, therefore, well banked up. Now there is one thing about the sapper man—when he makes a road he makes a good one; this road was a godsend, and was as good after four years wear and tear as at the beginning.

To understand the difficulties of supply to an army operating in Mesopotamia, one requires to visualize the geography of the country.

Start by imagining yourself in the hottest room in a Turkish bath, in a ship waiting to cross the bar; a low-lying coast is in front, fringed with palm trees round the mouth of a broad yellow river; slowly you proceed up this river known as the "Shatt el Arab." It is formed by the junction of the Euphrates and Tigris at a place called Kurna, a traditional site of the Garden of Eden, some 150 miles from the mouth.

The first place of note to which you come is Mohammerah, the headquarters of the Persian Oil Company; here the Karun river joins the Shatt el Arab. Along its banks runs the pipe line conveying the oil from the oil fields through nominal Persian territory.

After passing Mohammerah the river narrows to a breadth of between 800 and 400 yards, and the first signs



Map of the Near East

of war appear in the effort, a jolly bad one, of the Turk to block the channel by sinking a Boche ship.

The line of palm trees grows thicker, for now you are passing through the date-bearing belt, and soon Basra port comes in sight; this is 69 miles upstream. The desert is quite shut out from view by the belt of palm trees which runs inland about a mile. The British forces had fought their way into Basra across the desert at a place called Shaiba. At one time the battle was not going too well, the Turk being in strength, while the British force was only a brigade. At the critical moment, however, the Turk broke and fled and afterwards it was discovered that he had mistaken the dust, caused by the approach of some transport carts, for that caused by the arrival of reinforcements, so the transport native drivers really won the battle.

For an army operating in Mesopotamia there was in those days only one route and that was by the river. At Kurna, which soon fell, the Shatt el Arab ends and the Euphrates comes in from Nasireh, 100 miles to the west. Before continuing an advance north up the Tigris, the western flank had to be secured. This was done by the taking of Nasireh, a quiet, sleepy place some 112 miles northwest from Basra and close to "Ur of the Chaldees," famous for the ruins of its old temple to the Moon God, which dates from some 4,000 years B. C. and also being the birthplace of the patriarch Abraham.

A railway line was laid across the desert to Nasireh, the forerunner of the Baghdad-Basra railway, and the troops pushed forward up the Tigris toward Amarah. The Tigris, according to the Arabs, is an evil river, and I quite agree with them; the Turks slung bombs across it, and entrenched the banks, but despite all difficulties the troops forced their way into Amarah and a railway followed up the western bank, so that Amarah became the next jumping off place. Here supplies for the next advance were parked. Above Amarah the palm belt quite ceases, and the desert stretches to the horizon on the western bank and to the distant hills of Persian Kurdistan on the east. The climate here changes, you get out of the damp heat and come into a drier and better climate, with however no lowering of the temperature.

The winding course of the river is most exasperating; as the hot weather comes on the rain certainly ceases, but the snows, melting away to the north in the Armenian mountains, cause the river to rise, sometimes many feet in the night and areas of 100 square miles are flooded. The result is that it becomes most difficult to keep the steamers and their barges in the channel, as the river will sometimes fall in a night as quickly as it rose. It was no unusual occurrence to see a river boat with its barges high and dry, and there it would wait till the river rose again, a very serious matter for those on board as regards food and drink, especially the latter. The town of Kut, famous for its siege, was the real end of the river journey to Baghdad, for here a light railway was run over the desert to Baghdad across the field of "Ctesophon" to provide for this ancient land. It was possible for steamers at certain seasons to make the journey through to Baghdad, but it added a week to the journey. When Kut was finally occupied large stocks were placed there and those at Amarah diminished, the base depot at Basra supplying direct to Baghdad via Kut. The city of Baghdad is a disappointment to those with romantic ideas; it requires a good deal of imagination to bring it into line with the Baghdad of Haroun al Raschid's day.

Following our usual procedure the troops were not quar-

tered in the town, but clear to the south and west a large Ordnance Depot was formed on the western bank of the Tigris. Many a weary day passed before we got a road into it, and that only a mud one. Round about Baghdad the river banks are again green, with, in some parts, beautiful fruit gardens and one place christened "Devonshire" by Tommy, was really delightful. Over this area the dry heat continues, while in the winter months 25 degrees of frost have been registered, a great change from 125 in the shade for the hot weather.

At Baghdad the Euphrates comes to within some 40 miles of the Tigris and here is situated the great Hindya Barrage, the possession of which dominates all the grain lands on the banks of the Euphrates.

From Baghdad the Tigris goes on to Mosul, but is not navigable to steamer traffic, and a railway line of the Boche broad gauge was laid up to Shergat, 70 odd miles from Mosul.

Mosul was a perfectly filthy town though it is the only one in which the buildings are of stone. It is situated in a basin as it were, near to the site of ancient Nineveh and the city of Nimrod, and it was the headquarters of the British division protecting Baghdad from the north.

By river Baghdad is 600 miles from Basra, and Mosul is 200 miles from Baghdad; along this weary line of communications with its bunch of tentacles stretching out into the desert and the foothills of the wild country to the north and east, every requirement of the troops was sent. When you think of the heat for 4 months in the north and 5 months in the south running to 129 degrees and over at Basra, and the cold and wet of the winter you can imagine what the work of supply entailed, but to realize fully the difficulties of provision and accounting, you must add to all this the fact that it took, from the time they were demanded, 8 months for stores from home to arrive in the Baghdad Depot, and 5 months for those from India; also that when they did arrive they had been transshipped at least twice during the ocean voyage and again twice on the line of communication so that no consignment ever arrived as it started, in one bulk.

Now that we have as it were visualized the terrain and climate let us turn to the material available. As has been stated the Indian Ordnance Department was originally in charge. When the Royal Army Ordnance Corps arrived it was ascertained that there would not be sufficient personnel available owing to the already heavy strains on the corps from other and more important theaters of war, so it became, therefore, a question of fusing the two systems of work so that a system of intelligent co-operation would result, minimizing the dual control that could not be avoided.

The whole training of the Indian Ordnance Department was at variance with the virile methods of their home service brothers in arms, and, had it been possible the latter would have got on better without them, for even in the language difficulty the labor in Mesopotamia spoke either Arabic, Persian or Kurdish, and the fact that the Indian Ordnance Department understood Hindustani made very little difference for it must be realized that Hindustani was quite as much a foreign language to the dweller of Iraq as English. To anyone who has had experience of British Tommy working with other races, particularly eastern ones, the language difficulty is no difficulty at all; he manages to make himself understood and gets them to work in a way that has to be seen to be believed. I think I can honestly say that the troubles of the Ordnance in Mesopotamia or Iraq, as it should now be called, were in excess of those in any other theater of the war.

With an army working in such a climate and in such a country large native labor corps are a necessity; a special department has to be created to rule and guide this wonderful and polyglot crowd, and the Ordnance provision branch learns many new and wonderful names. The Indent branch grapples with Indents having no fixed scale to guide them, the labor officers rage with fury, for that is one of the curious traits in the British character: if you put a Britisher in charge of a crowd of the most tatterdemalion scallywags he at once adopts them as his children; he swears by them, and often at them, but—just you come and make a disparaging remark and there is trouble.

Not only had the Ordnance to contend with the lapse of many months before the stores demanded materialized, but when they did come, owing to having been trans-shipped at least three times (as I have already said) during the sea voyage and then handled another three times on the line of communication, it was not surprising to find, as I found in one case, that a box said to contain 1,000 razors, which looked intact, on being opened contained only 250. The remainder were strips of metal of sorts of about the same weight which had taken the place of the original razor and we never could find out where this was done.

Where, as in Iraq, there is a long line of communications an advanced base depot is necessary. Any duplication of depots is bound to be extravagant because of the locking up of stocks and the danger of duplication in provision. To obviate this the Provision Branch was established at Basra's, Baghdad's demands being met from Basra's stocks and the latter filling up from overseas. Later on, however, when reductions were the order of the day and only the army of occupation remained the Provision Branch was done away with and each depot made its own demands, which were sent through the office of the Deputy Director Ordnance Supplies in Baghdad in order to be sure that neither depot was ordering stores from overseas which were available in the other, a thing quite easy to do, but which will most certainly produce some language, if nothing worse, from the heads at home.

An ordnance officer has need of much patience; should he, after being informed that a case of dynamite has gone astray between his depot and the vessel, then in the process of being loaded, find the said case broached and a group of his wild labor crowd solemnly eating the sticks as if it were Edinburgh rock, he must not be angry. The above incident actually happened and, therefore, will probably not be believed.

The provision, storage, and issue of the many classes of oil in use by the army gave many an anxious moment to the C. O. O. of the base. You see the man who sent him the oil from overseas forgot that the drum containing the oil would probably get knocked about and if so might possibly leak; the result may have improved the bottoms of the ships, but when you unload a consignment of 10,000 tins of oil and find 8,000 empty you are apt to get left.

The provision of roads in the base depot being of the first importance and there being no stone in Iraq, it behooved the C. O. O., Lt. Col. Howell Jones, one of those men who is a born C. O. O., to do some clear thinking. South of Basra and 70 miles away in the desert lies a mound, or Arrarat, as these mounds were called in ancient times, now known as "Jebel Hamrin." Visits to it had shown that it was composed of some stuff which, even if the experts said it was not stone, was a fair substitute and the railway engineers thought it good enough to use as a foundation for their lines. The C. O. O. therefore, by ways that were reminiscent of Brete Hart's Chinaman, procured a quantity and roads appeared in the depot.

Buildings, the next difficulty, were obtained by the I. G. C. Major General Sir George MacMunn, an officer to whose

energy and foresight the Mesopotamia Expeditionary Forces owed a very large portion of their success.

Troops cannot fight with a long line of communications behind them, if that line has not been well and carefully constructed; it is as necessary as a good foundation to a building, if it is faulty, disaster will come sooner or later.

The conditions both at the base and on the line of communications (as could be foreseen) were enough to daunt most men, for to make a good job meant an expenditure of money running to millions and a wastage of human life that must have gone to the heart of a man who was kindness itself.

The depot soon began to take on an appearance of order. Quarters for the officers and warrant officers were built from timber, about which inquiry is not requested, and thus the last of the staff were housed, and protection from the killing sun obtained.

Lines of rail were laid into the depot and alongside the wharves, simultaneously with the building of the latter, and a magazine covering about a square mile appeared as if by magic in the desert.

It is very difficult with a temperature running to such heights, to keep the modern high explosives in use with armies of the present day fit for use and when, in addition to the heat, blinding sand storms lasting two and three days at a stretch were a common occurrence. The officers and men of the R. A. O. C. had a never-ending struggle against an antagonist who they felt must get them in the end. But they stuck it out as the white man does, gaunt-looking objects, coughing sand, kicking a football about in their time of leisure when malaria and sandfly let them out of grip.

No glory here, but a jolly good "strafe" if a shell was reported from the front to be a dud. In peace time the Baboo clerk, standby of the I. O. D., gives us sometimes a smile, but in wartime these same idiosynerasies raise Cain.

There was once a serious scrap coming off in the hills 100 miles and more to the northeast of Baghdad. A unit sent an urgent demand for necessary stores: the Baboo clerk through whose hands the indent passed observed an erasure not initialed by the unit commander, as laid down in Indian Regulations. At once the indent was returned to the unit with a request to kindly comply with Regulation—and return at earliest convenience. Can you beat this for tragedy? It says much for the temper of the R. A. O. C. that the many Baboos who, in that worrying country, worked alongside and were paid far higher than the British Tommy, lived to return to the bosom of their families.

In conclusion, I would like to draw the attention of all thinking soldiers to the great work that can be done away from the glory of the fighting line by those who can never get into the limelight, but without whose work no army can hope to win.

"Duds" and "Prematures"

By

R. L. MAXWELL
Member A. O. A.

THE ammunition engineer, manufacturer and consumer is constantly confronted with the possibility of producing and must be ever on guard to prevent "duds" and "prematures."

The word "dud," used in a limited sense, may be defined as a discharged, unexploded bomb, projectile or grenade, while the term "premature" is applied to the explosion of a bomb, grenade or projectile which occurs before the user intends the explosion to take place. The former represents not only a waste of money but a waste of effort, and effort applied at a time when effort is required for other purposes, while the latter injures personnel, matériel and, worst of all, the morale of using troops. It is possible therefore to boil down the ammunition problem to two "dont's." Don't produce a "dud"—don't produce a "premature."

To anyone who has been involved in the solution of the ammunition problem of the Army for any appreciable length of time, it soon becomes apparent that the lack of knowledge and appreciation of the magnitude of the ammunition problem before the World War is very conspicuous. In fact, it has often appeared to the comparatively small number of officers engaged in the Ordnance phase of Army ammunition that the pre-war Army as a whole only thought of its ammunition when it began to blow up storage depots or when actually needed at the guns. For example, maneuvers and field exercises of all kinds were conducted before the World War and to a certain extent are still conducted in our service without any attention to the actual or theoretical consumption of ammunition.

The necessity for simulation of actual service conditions in field maneuvers has always been very much emphasized for all phases of Field Service except that of ammunition supply and consumption. I recall very distinctly an occasion on which a second lieutenant of Field Artillery, quite new in the service, had the audacity during field maneuvers while acting as executive officer in a battery of Field Artillery, to telephone to his battery headquarters the information that orders for firing the battery could no longer be complied with as the ammunition was exhausted. The second lieutenant in question was sure of his ground because he had kept an actual record of the number of rounds of simulated fire ordered fired in his battery during the maneuver and sent the message relative to depletion of ammunition supply when the rounds of simulated fire equalled the number of rounds carried in caissons and limbers of the firing battery. Unfortunately, the only immediate reaction from this message was a rather emphatic order from the battery commander for the lieutenant to stop interfering with the problem by the sending of unnecessary messages over the telephone, and I dare say that if any second lieutenant will try the same tactics on his battery or company commander today he will probably meet with the same response.

However, it is possible that such a message might be received by an officer whose war experience has been such that he would understand the import of such a message and he would relay it on to the higher units of command and bring to the attention of all concerned the necessity for

some consideration of supply and consumption of ammunition in field maneuvers and exercises. This incident serves to illustrate the attitude of the Army toward ammunition before the World War, but the World War brought some changes and to quote from a memorandum issued by Maj. Gen. Edward F. McGlachlin, Jr., U. S. Army, Chief of Artillery and Commanding General of the Army Artillery, First Army, during active operations between October 7th and October 22nd, 1918:

"The ultimate problem of any artillery unit is ammunition. A gun without it is no gun, a battery, no battery—no matter *how efficient it may be in other respects. The German is interested only in the receipt of so many pounds of metal aptly located. He doesn't care how well the piece could have been served, if the ammunition had only come through.*

"Too many rounds are lost either at the position or en route to it. If a box of powder is left unprotected and gets wet, it is worse than if the powder had never got there, for in bringing it up someone has spent in vain labor that could have been profitably put on something else. If shells are at hand, but no fuses, the same result happens, and it does not help matters if the fuses were there, but got ground into the mud and lost."

The quotation shows the attitude of one of our distinguished artillery generals during actual operations and similar references and remarks will be found in the service journals and lectures delivered at the service schools. For example, the Chief of Ordnance, Maj. Gen. C. C. Williams, made the following statement in a recent lecture to the class at the Army War College:

"I think that most of us are willing to admit that the time has arrived when the country's military strength is directly applied against the enemy almost entirely through the medium of ammunition placed in the enemy's area by means of gun, aircraft, or other form of transportation.

"It follows, therefore, that the real mission of the Ordnance Department is, in general terms, to endeavor to make arrangements for an adequate supply of the most powerful munitions the country's resources and engineering ability are able to produce. This supply should, at the minimum, be equal in quality and quantity to those available to our enemy."

The Ordnance Department is responsible for the supply of the ammunition to the Army in time of war, up to, and including, the Army Ammunition Parks, which are field establishments for the supply of the troops of the Field Army. Three phases of this Ordnance responsibility will be discussed briefly: namely, design, manufacture and issue.

If the Ordnance Department is to be successful in its design of ammunition, it must embody in the design of all the items of the ammunition list the ideas and requirements of the combatant branches of the Army, the Infantry, Field Artillery, Coast Artillery, Chemical Warfare, and Engineers, and the Office of the Chief of Ordnance is so organized that a separate group known as the Technical Staff of the Ordnance Department is charged with establishing and maintaining contact with the combatant branches of the Army and the study of design in foreign countries and in the American Navy.

During, and immediately after, the termination of the World War, the necessity for marked improvement in all types of ammunition became apparent. The more important policies governing design and improvement were worked out and announced as a result of the study of policies by boards of officers representing the various branches of the Army. These studies received the approval of the General Staff and the Secretary of War and were given to the Ordnance Department to follow in post-war design. In general, demands were received for increased range and accuracy of artillery projectiles and certain refinements and improvements in other items. For example, the divisional gun before the World War was the 3-inch field gun firing the 15-pound projectile with a maximum range of 6,000 yards. The 75-mm. field gun was substituted for the 3-inch field gun after the United States became involved in the World War, firing a 13½-pound projectile with a maximum range of 9,200 yards. The Board which laid down the development policy demanded a projectile with a weight of less than 20 pounds and a maximum range of 15,000 yards. The larger caliber artillery weapons were covered in a similar manner, the general demand being for increased ranges without sacrifice of accuracy.

The increased range requirement is being met insofar as ammunition is concerned by improvements in design of projectile and the propellant. It has been found that the shape and position of the rotating band on the projectile affects the range and especially the accuracy of projectiles. An important change has been made from the blunt-nosed, square-based prewar projectile to the stream-line or boat-tail type of projectile and has resulted in material increases in range. The studies and investigations made in connection with the redesign of projectiles has paralleled the development of improved methods of obtaining data relative to the behavior of the projectile within the bore of the cannon and the first few hundred yards of the trajectory.

Extensive development has been carried on in the field of fuses for artillery projectiles to produce a few types of fuses to replace a large number of types now in service and at the same time to furnish to the service a fuse that is safe to handle and certain of action. That is, a fuse that produces neither duds nor prematures.

The users of artillery projectiles demand, as a primary consideration, a bore-safe fuse, that is, a fuse which cannot initiate explosion of a projectile within the bore of a cannon in which fired. The Ordnance Department is very encouraged with its post-Armistice efforts toward the development of a bore-safe fuse for both field and coast artillery and feels that considerable progress over the prewar fuses has been made. The introduction of aircraft in warfare has made the development of anti-aircraft artillery a prime necessity in this field and the ammunition engineer is confronted with a very difficult problem to solve, particularly in the matter of fuse design.

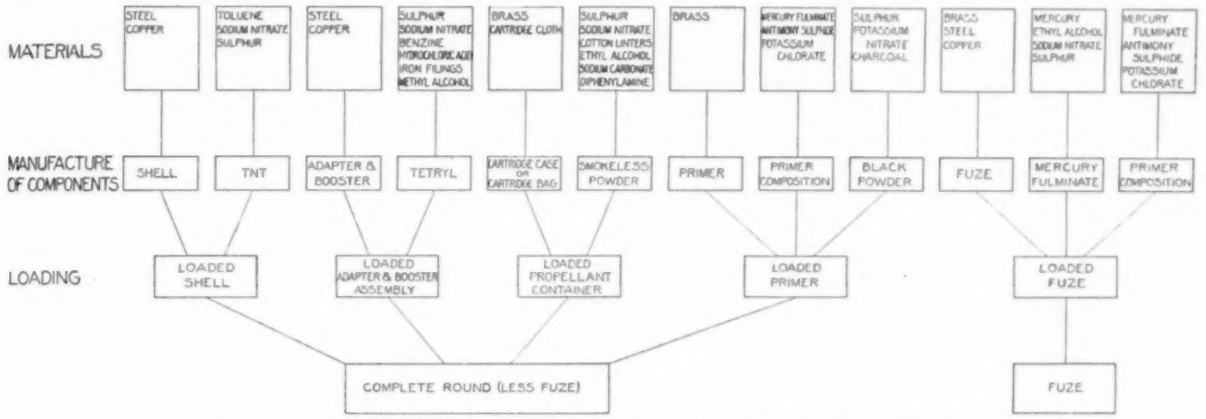
The development and manufacture of a mechanical clockwork fuse is new in this country and the efforts of watch and clock manufacturers to produce a satisfactory mechanical clock fuse have not resulted in a satisfactory solution of the problem up to date.

Paralleling the development of the mechanical clock fuse, the Ordnance Department is endeavoring to modify or improve upon its powder-train time fuses in order to fill the requirement with a fuse of a type similar to existing powder-train time fuses. It will be readily seen, however, that the varying altitudes through which a projectile must pass in anti-aircraft artillery firing very greatly complicate the problem.

In the matter of propellants for field and coast artillery, we are looking and hoping for a flashless, smokeless, non-hygroscopic propellant which will give us the same or equivalent ballistics as our present service powders, less the conspicuous flash of the gun on firing, and at the same time improve the regularity and uniformity of our propellant by being less hygroscopic than the present standard service nitrocellulose powder. In addition to development undertaken at Government Arsenals, the Department has been successful in obtaining the service of the largest commercial manufacturer of powder in the United States, with

the result that a reasonably satisfactory solution of the propellant problem for the 75-mm. field gun has been obtained.

The rapidly increasing use of airplanes has kept the designers of aircraft bombs very busy and spectacular results have been obtained in the development of bombs to be dropped from airplanes. Bombs developed vary from 25 pounds to 4,000 pounds in weight. The entire system of



Flow Sheet of the Manufacture of a Complete Round of Field Gun High Explosive Shells

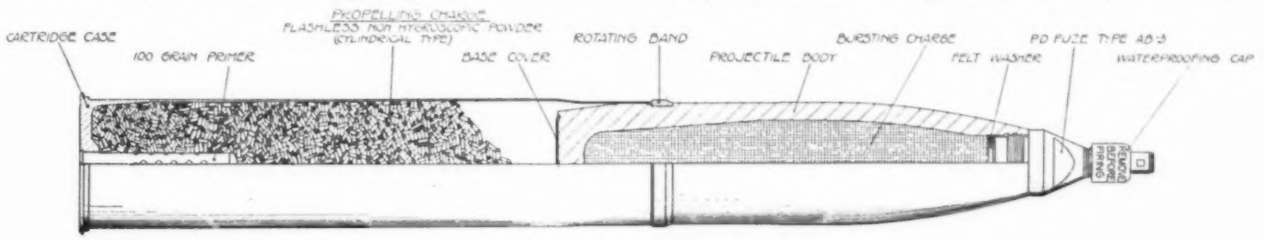
military pyrotechnics and their use is being improved upon by the development of 24 types of military pyrotechnics, a subject that was left entirely to commercial manufacturers prior to the World War.

In the field of explosives our engineers and chemists are constantly searching for improvements in methods of manufacture of standard explosives and for substitutes for some of the present adopted explosives, due to the difficulties encountered in quantity manufacture of these explosives in time of war.

In order that the using services as well as the Ordnance Department may be kept informed as to the satisfactoriness of designs developed, it is planned to follow the system this year adopted, and put into practice of manufacturing small lots, 1,000 to 2,000 rounds of ammunition, embodying in these lots the last word in development of each of the elements of complete rounds of ammunition. For example, this year the Department manufactured 3,000 complete rounds of 75-mm. high-explosive shell ammunition. Fifteen hundred of the rounds contained propellant developed by the Picatinny Arsenal; the other 1,500 contained propellant developed by the Du Pont Company, and a new primer found necessary because the newly developed smokeless non-hygroscopic powder offered by the Du Pont Company could not be ignited properly with the standard service primer. The projectile used in the assembly of the 3,000 rounds was the Mark IV projectile, a stream-like type developed during the World War and put into production near the end of the World War.

The high-explosive bursting charge was cast TNT, the standard accepted 100 per cent explosive of the World War. The fuse used in the 3,000 rounds is an experimental type known as the A-B No. 3 fuse, a bore-safe, super-quick, point-detonating fuse. One thousand rounds of this experimental lot of ammunition have been issued to the Field Artillery School at Fort Sill, and another 1,000 rounds for the use of the Field Artillery Board at Camp Bragg, the remaining 1,000 rounds being retained by the Ordnance Department for storage tests and subsequent firing tests. It is planned next year to bring out a small lot of 155-mm. howitzer ammunition, using for the assembly of the lot such newly designed elements of the round as are available at that time.

In passing from the development or design phase to that of manufacture, I wish to call to your attention the necessity of knowing at all times the quantities as well as the types of ammunition required by the Army. The Chief



75-mm. Assembled Round

of Ordnance has enumerated in instructions issued to his office a number of things which must be available in order that the Department may manufacture the ammunition required:

(*a*) An estimate of requirements of munitions for a probable war,
(*b*) A statement of stocks on hand,
(*c*) An estimate of the production capacity of the country for munitions, together with the cost of producing the same,
(*d*) An approved procurement program,
(*e*) A complete set of specifications covering the munitions to be purchased,
(*f*) Contract forms and price limits,
(*g*) Progress report forms,
(*h*) Stock record system and method of controlling assemblies,
(*i*) Consolidated progress report.

A proper estimate of requirements for ammunition is naturally based upon the approved plan of the War Department for the mobilization of troops in time of war. The War Department having announced its plan for the

mobilization of troops in time of war, it is necessary for the Manufacturing Service of the Ordnance Department to solve the problem of procuring ammunition for issue to the troops as mobilized.

The manufacture of ammunition during the World War in the United States was a tremendous industry, and the number of plants and capacity to produce constructed and put into operation during the war were far beyond the conception of anyone connected with the problem prior to the World War, but these war plants are rapidly being converted to other uses or torn down. We have, in time of peace, in the United States many plants capable of producing the metal components of ammunition and a limited number of plants capable of producing the explosive components of ammunition but we did not have prior to the World War and have not today any plants equipped or capable of immediate use as loading and assembly plants of complete rounds, or components of complete rounds containing explosives. It is the loading and assembly of ammunition, therefore, which demands the attention of the Manufacturing Service of the Ordnance Department and requires the careful preparation of war plans for obtaining the necessary output of complete rounds of ammunition in time of war.

There are four general requirements for manufacture of ammunition in time of peace:

(*a*) Manufacture of complete rounds and components to fill original deficits in the authorized war reserve,

(*b*) Manufacture of complete rounds and components to replace material consumed in training firings or material condemned and disposed of on account of deterioration,

(*c*) Manufacture of complete rounds and components due to obsolescence of types in stock,

(*d*) Manufacture on a minimum scale to keep alive a knowledge of the art.

With the limited appropriations now available the (*d*) requirement is the only one receiving even reasonable attention. Of course such manufacture as is going on is being applied against requirement (*a*).

It is only a matter of a very few years until requirements (*b*) and (*c*) must be considered or our war reserve of ammunition will either disappear or what is worse, become a pile of dangerous "duds."

The ideal system for supply of ammunition would be one that would create an uninterrupted flow from the factories to the combat troops. This entails reservoirs called depots to absorb the surplus and provide a reserve during periods when the army rate of consumption is exceeding the rate of production. The depots also give flexibility in that the flow from them can be directed to first one point and then another as the need arises.

In the army area ammunition is in general stored in and issued from army ammunition parks, corps ammunition dumps, and division ammunition dumps.

Each unit has a "munitions officer" who is directly charged with responsibility for maintaining an adequate supply of ammunition in his unit. These munitions officers form a chain from front to rear, each calling upon the next larger unit for supply. Each also makes reports to the next larger unit giving the rate of consumption of ammunition and the amount available for his unit. These reports, although burdensome, especially in action, are very important. No munitions officer can make a proper distribution of his ammunition to his organizations unless he knows the state of supply in those organizations. If he makes the distribution in a haphazard manner some of his units may have too much ammunition and others be entirely out. The inefficiency of this is obvious.

This principle extends back to the War Department and the necessity of regulation increases with the size of the unit.

For example, when the Allies were making the attack on the Marne that began on July 18, the French General Headquarters issued an order to all armies using French 75-mm. ammunition stating the daily rate of fire that each army might use, that is the rate at which each army could expect to receive replenishment of 75-mm. ammunition stocks. This allowance varied from an unlimited rate of fire in the armies making the attack on the Germans to zero for those in the quiet sectors of the Vosges.

In other words, all the 75-mm. ammunition being manufactured was placed at the disposal of the attacking armies and all ammunition trains were routed to their sectors and none were sent to the quiet sectors.

A munitions office that handles considerable quantities of ammunition must keep a set of books exactly as a large store does. To take a corps munitions office for an example, with several divisions in the corps: the corps munitions officer receives daily allotments of ammunition from the army muntions officer for the various calibers and kinds. These allotments cover ammunition in several army munition parks. The corps office immediately enters the various amounts as credits in accounts opened with each caliber and type, and also in an account with the particular depot. He thus knows at all times from one account his available balance of the particular type of ammunition and from the other accounts he knows the available balance of that type of each depot.

From these figures and from the tactical situation the corps office issues orders authorizing the divisions to send ammunition trains to designated army parks to get ammunition.

The necessity for accurate bookkeping is apparent, for if an ammunition train in a hurry for ammunition travelled fifteen or twenty miles and found that the corps had no credit at its destination the delay and confusion would be serious.

In transporting ammunition, railroads should be used as far to the front as possible. Narrow-gage railways can often be run quite far up, and in some cases directly to battery positions. The use of railways relieves congestion on the roads, and one small railway car can carry the load of three ordinary trucks.

Trucks are the usual mode of transportation of ammunition in the army area. Each division has an ammunition train, as has also the corps and the army.

The corps and army trucks assist the division trains by hauling from army parks to corps and division dumps.

From the latter point horse transportation does the bulk of the work. The trucks sometimes carry forward to or very near to battery positions and in the future automotive transportation will be used much more than was the case in the World War.

The handling of ammunition in division and corps dumps will be done by the field artillery personnel. In the army parks the Ordnance Department will furnish the personnel and the Army Ordnance officer will be responsible for the management of these parks. He must see that the roads are kept up, the ammunition must be properly segregated by kind and lots, and the position screened against enemy observation.

These parks and also smaller ammunition depots should be near but off main roads. There should be separate entrances and exits so that truck trains will not become entangled in the depot.

In the early part of the war the French depots were laid out with the regularity of a town; that is, an American town. But towards the end all new depots were being placed wherever possible in woods to avoid airplane observation.

Each depot of course keeps a set of books and makes a daily report to the munition office to which it pertains. This report shows the ammunition on hand of each type against which orders may be drawn for issues.

One of the most difficult features of artillery ammunition supply is to get *complete rounds* to the batteries. Periodically during the war frantic appeals would come in saying that no fuses or perhaps primers were available. In the Argonne an officer from a neighboring corps came in to an Ordnance office and appealed for a truck load of powder for 155's, saying that his unit was in action and had everything but powder. He had been started out with orders not to come back without it. He was given the truck load, although it was difficult to obtain extra charges in excess of allowance of complete rounds.

In conclusion it is again pointed out that all concerned must remember the two "dont's."

Don't produce a "Dud."

Don't produce a "Premature."

And remember as the Chief of Ordnance has recently stated:

"To solve the problem properly in time of war requires practice in time of peace."

The Problem of An Infantry Rifle

By

EDWARD C. CROSSMAN

WITH the late war far enough down the halls of history to permit of a correct perspective, there seems little need to argue the necessity of a self-loading infantry rifle. The question is rather one of a self-loading infantry rifle for the necessity.

Tentative tests have been conducted during the past year or two of various types of self-loading rifles suitable for use by the infantry, but it is doubtful if such tests ever result in the unqualified finding that a satisfactory self-loading rifle has been discovered, in view of the unfortunate fact that funds are utterly lacking for its manufacture. Cessation of test and adoption of a sealed pattern of rifle might result in our failure to get a still better arm.

With two or three million rifles in store, with Congress determined on the strictest economy, and with the arsenals unhappily losing even that small, highly skilled nucleus of workers enjoyed before the war, the mass production of a new infantry rifle is as unlikely for the next five years as the building of fifty new post-Jutland super-Dreadnaughts.

Possibly an ideal war-preparations form of Government which permitted of armament without taking the legislative body into the confidence of the great General Staff, and thus in effect, making public the sort of engines of war being built, must necessarily be such an absolute monarchy as that of Germany before the war. Such government, certainly not ideal during times of peace, does permit the war-planning body to decide whether to confound the enemy by the sudden appearance of a new engine of war—such as the giant siege mortars of Germany and Austria—or to discourage a potential enemy from hostilities by judicious announcement of the new armament in plenty of time for it to have a deterring effect. A little unostentatious display of well-developed biceps has prevented many a potential fist-fight.

A government by the people can never hope to cope with a monarchy as to secrecy of preparation for war; therefore its only course is to keep its cards on the table—and endeavor to hold a hand strong enough to discourage any hopeful and militant nation, able to put in long years of "secret practice," like a college football team just before the big game.

Obviously by the time an American congress is persuaded of the advisability of spending enough money to tool up for an entirely new type of infantry rifle and to produce enough of the new weapons for our present small army, the general staffs of other nations will know as much about the new rifle as our own General Staff.

The task of the Ordnance Department, therefore, is to encourage hopeful inventors to submit their designs for test and to cooperate with the inventors in the improvement of the more hopeful types submitted.

Tactically, the greatest argument in favor of a self-loading rifle for infantry is the fact that it puts the semi-trained man on nearly the same level as the well-trained one. The chief difference remaining is that the well-trained man is more careful as to his aiming and trigger release.

With any form of hand-operated rifle fire speed depends on training, the same sort of practice-acquired technique necessary for piano playing. Compared to the well-trained rifleman of a National Match team, for instance, the "rookie," with a bolt action rifle reminds you of the graceful movements of a bear cub with a fountain pen.

Put the two men prone with a line of targets opposite them, with no limit as to ammunition supply or speed of fire, and the well-trained man will fire about two shots to the other's one and will keep up his fire longer into the bargain as the rifle heats and requires more and more force to operate the bolt.

But devote the month or two months available for the training of the recruit to nothing more than correct sight alignment and trigger squeeze, and there will be little difference in the fire rate of the two men. The necessity for learning rapid and smooth bolt manipulation with the minimum of rifle disturbance is gone. There remain only correct sight alignment, and smooth trigger release, with the rifle disturbed only by its own recoil, not by the wrestling of a little-trained man with the bolt handle in the right angle motion peculiar to bolt action rifles.

Fire control would become more difficult with the greater fire rate, and the utter absorption of the soldier in looking through his sights and squeezing the trigger.

Certain events in 1918 seemed to demonstrate that fire control, as some musketry enthusiasts understood it, is largely on a level with cavalry charges on field batteries. Under the "gang" system of platoon and section leadership with comparatively loose touch with the units on either side,

the old idea of controlling the fire of massed bodies of infantry much as one would play a fire hose, is somewhat to be doubted as being practical for future warfare. Such fire is much better done by machine guns, machine rifles, or even automatic rifles, such as the light Browning. The open field phase of the late war seemed to indicate that targets in modern infantry fighting are those which occur from moment to moment and permit of only the simplest form of the various and possibly complicated systems of target designation worked out by musketry enthusiasts.

Digest of the opinion of dozens of officers concerned in that most unethical and "untextbook" advance through the Argonne develops that fire control consisted largely of infantrymen shooting hither and yon at isolated targets, more often picked up by the individual riflemen than indicated by squad, section, or platoon leaders. Use is said to have been made of tracer bullets by scouts and unit leaders to indicate the things most urgently requiring hitting, such as machine gun nests. Once such a target is developed, it is obvious that the faster a fairly accurate fire can be poured in, the earlier would that deadly weapon, the machine gun, be eliminated from that phase of the fight.

Trial of the tracer bullet idea at Camp Benning in 1919 developed that, while more simple and positive than any previously used method of target designation, the scheme was not entirely satisfactory because of the difficulty in tracing out the white spark from other than a position close to and nearly to the rear of the firer. Even without the present much improved tracers the method proved certainly superior for indicating obscure targets, such as a bit of brush without object near to it to serve as a reference point, which is a fault often noted on modern well-shelled battlefields.

Obviously battles of the future will be fought over such terrain as the Argonne, if such is available, because it is beautifully adapted to defense, and in any event the defense will be conducted in much the same manner in which the Germans handled their own masterly rear-guard action.

The fact that our own army left more plunder on the field in the advance than the Germans did on the retreat is sufficient comment as to "rout" that took place.

The man who has to have something pointed out to him at which to fire will be increasingly out of luck because nice long, even fire trenches for the defense infantry are going to be increasingly scarce.

Careful inquiry while stationed in Washington, and while in close contact with officers of the A. E. F. while on duty at the Small Arms Ballistic Station in Florida, failed to discover a man who had told or been told the location of a target by any more than the simplest and crudest method with even the horizontal clock-face not often used. The infantry situation will more and more work into an organized *sauve qui peut* situation so far as fire is concerned.

Combined sights, auxiliary aiming point, etc., make beautiful textbook problems and demonstrations, but the machine gun and the machine rifle should largely take over such situations, and the true field of infantry fire will be hitting single targets on the move at ranges of much less than a half mile.

Technically, an ideal self-loading rifle entails a new cartridge. Our own splendid 1906, modeled in its 1903 form closely on the German Model 1888, was good enough for a bolt-action rifle, although not ideal, in that it lacked taper in its powder chamber portion and was thus more easily locked by the fact of a soft case, a rough chamber, or an over-heated barrel.

Improvements in powder make possible the service cartridge ballistics with a far smaller case and over-all cartridge length, something much to be desired in a self-loading rifle. The new Savage .300 cartridge gives our service cartridge velocity with a .30 calibre bullet of the same weight as that of our 1906 cartridge, and yet is over-all 22 per cent shorter than the 1906 service cartridge. The powder chamber diameter and the head diameter are practically the same as the 1906. Wherefore, given a case of this length, with larger head diameter, and larger diameter of powder chamber, the ballistics of our present case with heavier bullets than the 150 gr. service, could easily be duplicated.

A shorter cartridge means a shorter bolt stroke, and ergo a shorter receiver, lighter weight, and less clumsiness of form, not to mention economy in magazine length.

Obviously a diminution of calibre is desirable, from the present .30 to some figure between this and .25-inch, such as the British .27, ready for adoption about the time war broke out. Only the British error of a too heavy bullet should not be repeated. Flatness of trajectory over ranges less than 800 yards should be the keynote, with machine guns using heavier and boat-tail bullets to take care of the longer range fire, which could be shared by such automatic rifles as the present Browning.

This in turn means a light bullet at very high velocity, 3,500 ft. secs. or more if the problem of metal fouling can be solved at this velocity.

This would make possible a four-range rear sight up to 800 yards, for instance 300, 500, 700 and 800 yards, then with hundred-yard steps to the extreme of the sighting scale. A slow motion screw such as was embodied in the British short Lee-Enfield rear sight, could take care of the target rifleman. Some method of easy and positive lateral adjustment should also be provided, but not necessarily a "wind-gauge" *per se* for other than plain target shooting. A rifle of such ballistics once "zeroed" laterally for the soldier, would need no fussing around with lateral movements on the battlefield.

A minimum of less than ten shots would be unthinkable as magazine capacity.

The mechanics of the self-loading military rifle are more difficult than at first might appear with the self-loading rifle in common use by sportsmen.

Military use absolutely rules out one of our two makes of sporting rifles—that using a straight blow-back breech bolt, opposing cartridge thrust with bolt inertia and the resistance of the main and retractor springs.

A somewhat carefully worked out balance between thrust and resistance is obvious for this type of rifle to work. Dirt, rust, injury to parts, obstruction in barrel, or overload might easily destroy this balance to the end that the rifle would either not function at all, or else would blow open with emphasis enough to wreck the receiver.

The other type of sporting rifle, the Browning, makes use of the sliding barrel and bolt, recoiling under cartridge thrust, and not unlocking until they reach the rear of their stroke which is more than the length of a loaded cartridge. The time interval in which the bolt and barrel remain locked together affords opportunity for the pressure to fall and bullet to leave the muzzle. Obstructions and over-loads can only make the recoil speed of barrel and bolt a little higher, and there is still sufficient delay to permit the internal fuss to wear itself out without erupting fireworks from the receiver.

The sliding barrel type of rifle, however, entails a comparatively light barrel, and a barrel tube or cover on which the sights are affixed, similar to some foreign military rifles of the bolt-action type. The Belgian and Danish rifles are instances of this barrel tube form of construction.

However, while a blow on the barrel cover of the bolt action rifle having this sort of design, does nothing more than destroy its outward beauty, with a sliding barrel it

might well disable the rifle. While the barrel may bear only in guides at the forward and rear ends and not touch the cover elsewhere, still the tender care with which the average infantryman treats his rifle in the field would infallibly produce a generous percentage of rifles "laid out" from accidental blows that would depress barrel cover enough to interfere with barrel movement.

The problem of holding a rifle firmly locked against cartridge thrust, and still using the same thrust to actuate the bolt parts, is much like the familiar one of lifting one's self by one's boot-straps. The matter resolves itself into one of keeping the parts locked against the highest pressure, and then unlocking them in time to make use of the remaining pressure. The higher the pressure, and the longer the rifle barrel, the greater the problem.

The gas-operated manner of unlocking the breech parts and operating them is the simplest solution, but a gas-operated military rifle has certain grave objections, such as care and protection of the gas tube, prevention of the corrosion that creeps into the barrel via the gas port from the dirty parts below, and weight of rifle, that make that type of arm hardly desirable for issue in millions to a great army of comparatively untrained men. If not carefully designed, a little increase in the internal gas pressure may easily wreck the rifle.

Mexico had a tentatively adopted gas-operated, self-loading rifle, the Mondragon, some years before President Diaz found it expedient to try a French climate for his health. One of them was sent to Camp Benning from the spoils of the German arsenal at Coblenz. The arm functioned very well with the low pressure, blunt nose, old type 7 mm. ammunition for which it was designed, with a pressure of not far from 40,000 pounds per square inch, but when somebody "rang in" a modern type spitzer, high velocity 7 mm. cartridge with 50,000 pounds pressure, the increased thrust of the piston and bolt cracked the receiver housing, and might have wrecked the rifle. Such increase with a bolt-action rifle could have done no other harm than increasing the recoil, and possibly smearing the case over the face of the bolt, if the increase extended over the limits of the case strength. A cartridge giving 62,000 pounds fired in the service rifle, with its normal cartridge pressure of 50,000, produces no visible results different from those of the service cartridge.

The recoil-operated arm may make use of a number of varying applications of thrust on bolt parts or rifle movement.

One of them, for instance, tried at the Springfield Armory made use of the slight set-back of the primer to start the bolt-unlocking cycle of movements, the slight delay in the movement of the primer under the maximum gas thrust sufficing to permit the internal pressure to fall and the bullet to emerge from the muzzle.

Another is the forward moving barrel principle used on a self-loading rifle submitted to the Ordnance Department by Sir Charles Ross, of Canada, ten years ago, and again in 1917.

A self-loading pistol, the Swarzlose, made apparent use of this principle, although there remained the doubt whether it operated by barrel moving forward or gun moving backward from the barrel, which was also the probable explanation for the rifle of Ross.

Still another application of the recoil principle is the Sjogren, sold in England in the forms of a rifle and a shotgun prior to the war. In this arm a freely sliding weight on top of the bolt part moved forward under recoil movement, operating to unlock the breech bolt and start the cycle of self-loading movements. What actually took place was of course the rifle moving backward and the weight, held by its inertia, remaining where it was, the result being the same as if the weight had moved violently toward the muzzle. There is of course no difference in the result, whether somebody pushes a fist at the end of a stiff arm into your nose, or whether you take a run and push your nose into a fist at the end of a straight arm. The collision fact remains.

There is still another, made use of by the Thompson submachine gun and by the self-loading military rifle made for that company by the Colt Company and submitted at the Springfield tests.

This is the Blish principle, which may be defined as one making use of cartridge thrust to open the bolt when the gas pressure has fallen sufficiently to permit the locking parts to free from their adhesion to their locking surfaces. As long as the gas pressure remains high, these parts cannot move.

In turn this entails making use of locking bolt or bolts operating at a critical angle to the movement of recoil thrust. If this angle is too great, the arm will not operate. If the angle is too little, the arm becomes a blow-back, with the accompanying violence of movement of parts opening under straight, high gas pressure. The arm may be classified as a blow-back but firmly locked while the gas pressure remains high and not depending on inertia of bolt or spring resistance to delay the bolt movement under cartridge thrust.

Much to the embarrassment of designers this self-opening of an arm with the falling of gas pressure is not confined to arms especially built for the purpose.

The writer years ago, making some tests of the relative strength of breech bolts of sporting arms, was much surprised to find a certain model of lever actuated sporting rifle standing with the bolt partly open, the fired case still in the extractor claw, and the lever partly depressed. The rifle, an old one, was without the usual catch which serves to hold the lever against the lower tang, but a rifle depending at all on such a trumpery little catch would of course not be much of a rifle.

Three times did this self-opening occur, under very heavy loads of powder. It was not at all a "blowing open" in the destructive sense of the word because there were no signs of case damage, and the fact that the case remained peacefully in the grip of the extractor proved that the movement had not been accompanied by high gas pressure. Obviously it had not taken place until the highest pressure was off the barrel, and the locking bolts freed from their adhesion to their cuts in the receiver. In this type of rifle the locking bolts, working in slots in the receiver, enter the breech bolt at an angle—estimated as I remember it—of about 10 degrees nearer the bolt direction than a right angle, in other words at an inclination of about 80 degrees to the axis of the bore, and the movement of the bolt.

Commander Blish, of the Navy, read my tale of this happening as printed in a magazine and called on me to compare notes. He told me that they had found, in trying a new type of interrupted screw breech bolt in a big gun that the bolt held beautifully under service charges, but incontinently unlocked with saluting charges. The inference was obvious that insufficient gas pressure to hold the locking parts in close contact with their locking surfaces would cam open the breech bolt.

This was the genesis of the Blish form of locking bolt under which plan the Thompson guns are made.

It would appear that nearly any form of breech-locking mechanism which does not have the final portion of the locking movement at practically 90 degrees to the line of thrust of the cartridge is in danger of opening itself.

Some years ago the designers of a double gun attempted

to lock the barrels of their gun against upward movement by a bolt sliding into an inclined "bite" in the lower lug, the line of bolt holding being at about 80 degrees to the upward thrust of the barrels. They promptly found that the gun would unlock itself and open with each shot; that is the motion was sufficient to cam back the locking bolt. They therefore added to the lower lug a surface at right angles to the thrust upward, and put a similar surface on the locking bolt, and had no further trouble.

Another double gun which makes use of a rotary "hook" form of bolt engaging in the upper or barrel lug, depends largely on a very heavy spiral spring to keep the gun closed and locked. Removal of the spring permits the gun to open itself. Test with silver paper, easily broken, stretched between barrel and frame, proves that even with the spring forcing the bolt home, the gun partly opens on discharge, breaking the paper, but performing too quickly for the eye to detect the slight movement.

Obviously the Thompson type of gun, depending on friction, on the adhesion of the locking parts under gas thrust, likewise depends on a uniform condition of friction. Wherefore they provide for means of oiling this gun, both submachine gun and military rifle, by means of felt pads within the receiver, impregnated with oil.

While the submachine gun, a special purpose weapon intended largely for police and kindred uses and not for the dirty, hard conditions of the battlefield, works in a quite satisfactory manner, the fact of oiling being required for the infantry rifle is in itself enough to bar it from consideration as long as this requirement exists.

Machine guns offer examples of oiling bolt and parts or cartridge case as does the Thompson rifle. The Austrians used one, at least in pre-war days, which injected a drop of oil into the chamber with each bolt stroke. Machine guns, however, are entirely different from infantry rifles in the care they are likely to receive.

Personally I have no doubt that if our Government went to John Browning with war on its hands, and a request for a satisfactory self-loading infantry rifle, it would get the design within 30 days; only this is no time to make a new type.

Probably that which would do most toward the development and manufacture of a self-loading infantry rifle would be a catastrophe which would remove about two million "obsolete" Model 1917 rifles now in store.

Infantry Artillery Weapons

Model of 1923

By

K. F. ADAMSON
Member A. O. A.

A SHORT time after the Armistice the Ordnance Department was authorized to proceed with the design and manufacture of a cannon for use by the Infantry which would function both as an anti-tank gun and as a weapon to replace the 3-inch Stokes mortar. The basic requirements were that it should fire an armor-piercing shell through one inch of armor at 500 yards and that it could be used for plunging fire at angles greater than 45 degrees for ranges from 400 to 2,000 yards, while the complete unit was required to be sufficiently mobile to accompany the infantry at all times either for draft on its wheels or by carrying.

After numerous studies, the infantry howitzer, model of 1920, was designed and built. The carriage of this unit was so constructed that it would mount a 1.8-inch, 25-caliber gun firing a 3-pound shell at a muzzle velocity of 1,450 feet per second, or a 2.24-inch howitzer of 13.3 caliber length firing a 6-pound high explosive shell at a muzzle velocity of 700 feet per second. In the trials of this unit, it was found that the armor-piercing requirements were fulfilled when using the 3-pound shell, but trouble was experienced in getting 1.8-inch high explosive of 4.5-pound and 5.6-pound to fly true with the resulting tendency to land on their base. The 6-pound high explosive shells in the 2.24-inch howitzer were reasonably satisfactory, but as these did not have the capacity of the 3-inch Stokes mortar shell, an effort was made to utilize 8-pound and 10-pound shells, which were unsatisfactory for the same reason as the heavy 1.8 inch.

Much valuable time was lost in attempting to make this unit give high velocity for armor-piercing conditions, and low velocity for the plunging fire at short ranges, and so, after rather exhaustive tests, it was recognized that the solution was fundamentally wrong, and consequently the unit was discarded.

Approval was recently granted to change the specifications of the infantry matériel to permit the design of two weapons; one to be used for anti-tank work and for firing against small known targets, and the other to be used for plunging fire against personnel or where a Stokes mortar shell would normally be used. The additional requirements for these weapons were laid down along the following lines: that the unit could be carried by man; could be drawn on the road; could be carried on pack animals or transported in trucks. In addition, no component part could weigh more than 75 pounds and the complete unit should not appreciably exceed 300 pounds in weight, while other characteristics desired were that the dissembling into its component parts should be done without the use of any but the simplest tools, and that the time consumed be only a few seconds.

With these requirements in mind, the Ordnance Department has recently designed and built wooden models of the following weapons: a 37-mm. gun, a 2.24-inch infantry mortar, and a 75-mm. infantry mortar. These are described in detail in the following discussion, with photographs and illustrations of the wooden models.

37-mm. Gun and Carriage, Model of 1923

This gun and carriage is illustrated in Figure 1, which shows it in firing position for maximum elevation, while Figure 2 illustrates the four loads into which the complete unit can be broken up for man pack.

The gun consists of a single layer tube to which is

threaded the breech ring containing a drop sliding block. The firing mechanism consists of a hammer operated by a lanyard which strikes the firing pin, the design being similar to that on the 155-mm. howitzer, model of 1918. The front

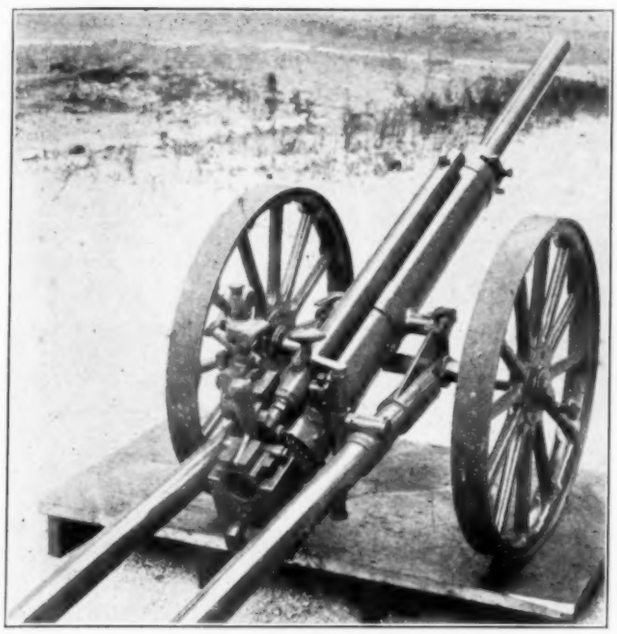


Figure 1

end of the gun tube has spline keys formed integral with it, which prevent the rotation of the gun during recoil, as well as guide it into battery during counter recoil. Slightly to the rear of these keys there is a short length thread which

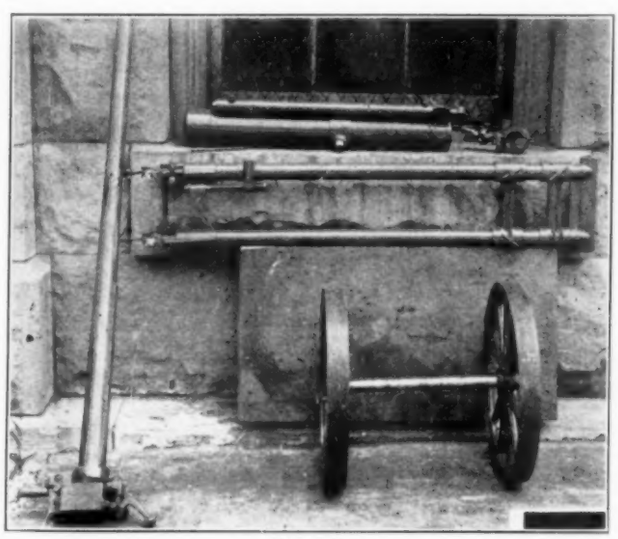


Figure 2

is slotted to engage a nut in the cradle, thus locking the gun to the cradle.

The carriage consists of the cradle, trail, axle and wheels. The cradle is a steel cylinder housing the sleigh and counter recoil spring. The recoil cylinder is secured to the steel cylinder and consists of a piston rod with a throttling valve in the piston head. A helical counter recoil spring is enclosed in the steel cradle cylinder and surrounds the gun. The steel cradle is designed to support the gun on bronze rings at each end, while felt washers are provided to keep the bearing surfaces of all recoiling parts clean.

The elevating gear is a screw on the right side and is pivotally attached to the trail and cradle. This screw is operated by a crank located at the top which permits an elevation of from minus 5 to plus 20 degrees. Due to the possible injury of the serving personnel, this design has been changed by locating the elevating screw on the left-hand

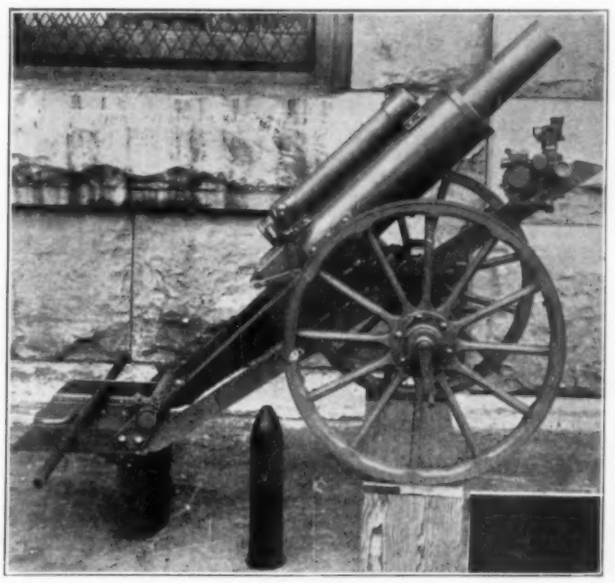


Figure 3

side, but its operation will not be appreciably affected. The carriage has axle traverse, which is obtained by rotating the axle by a crank on the outside of the wheel. Square threads on the axle meshing with suitable bushings in the

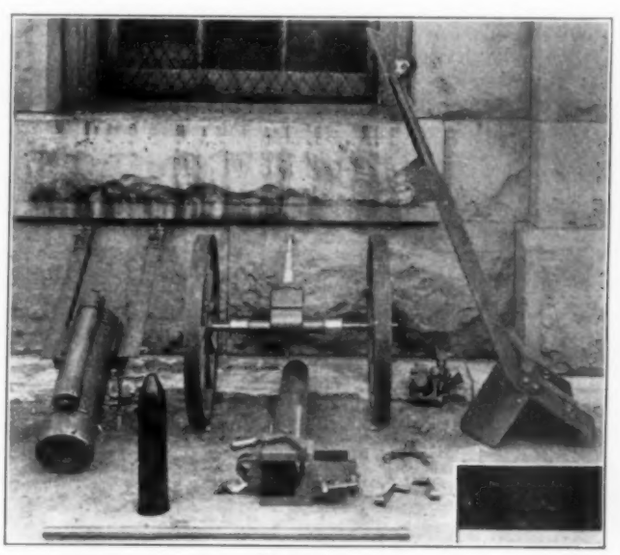


Figure 4

trail give a translating effect when the wheels are held rigid. The trail is built of steel tubes with a casting at the rear end for the spade and two at the front end to support the cradle trunnions on the one side and the axle bearing on the other. These trail tubes telescope so that it can be used at full length when stability is required at zero degrees elevation.

It is anticipated that this gun will fire a 1.25-pound shell at a muzzle velocity of 2,000 feet per second, which is sufficient to penetrate one inch of armor at 500 yards. The range at its maximum elevation of 20 degrees will be in

excess of 5,000 yards, which is greater than can normally be utilized by a weapon of this type. The component loads of the gun tube, cradle, trail, and axle with wheels do not exceed 75 pounds in the original design, although it is anticipated that the last-mentioned unit will be increased

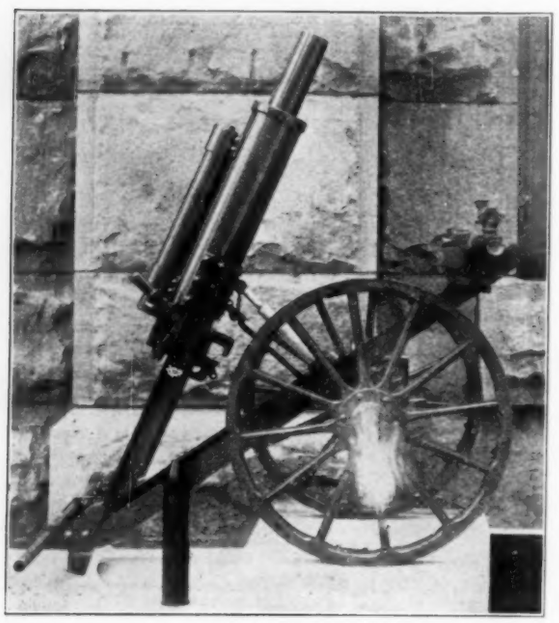


Figure 5

slightly to insure excess strength when drawn on the road by animals.

The following procedure is necessary to disassemble the unit into its four component parts: First, remove the pin connecting the piston rod to the gun lug, after which the locking nut at the forward end of the cradle is rotated, disengaging the tube from the counter recoil spring. The gun is now free, and is removed from the cradle by sliding to the rear. Second, lift the latch handles over the trunnion caps and rotate them forward thus releasing the trunnion caps and axle bearing caps. The elevating screw is then disengaged from the cradle, after which the cradle may be lifted off of the trunnion bearings, and the trail lifted from the axle.

A comparison of the 37-mm. gun, model of 1916, and the 37-mm. gun, model of 1923, is given in the following table. From this comparison it will be noted that the muzzle energy per pound of the unit has been increased over 200 per cent in the new design over the model of 1916:

	37-mm. Gun	
	M. 1916	M. 1923
Length of gun in calibers	19.94	39.5
Weight of projectile, lbs.	1.234	1.25
Weight of charge, grains	500	1,400
Max. powder pressure, lbs. sq. in.	18,500	20,000
Muzzle velocity, ft. per sec.	1,276	2,000
Muzzle energy, ft. tons	13,945	34,703
Weight of gun, lbs.	56	75
Muzzle energy per lb. of gun in ft. lbs.	557.8	1,387.8
Ratio	1	2.488

	37-mm. Gun Carriage	
	M. 1916	M. 1923
Diameter of wheels	37.75	24
Width of track	33	21.5
Overall length of vehicle	75	140
Overall height of vehicle	37.75	26.5
Overall width of vehicle	57	26.5
Weight of gun and carriage	360	300
Muzzle energy per lb. of unit in ft. lbs.	86.0	263.0

75-mm. Infantry Mortar and Carriage, Model of 1923

The 75-mm. Infantry Mortar and Carriage, model of 1923, is shown in Figures 3 and 4, the first illustrating the mortar in firing position at its minimum elevation of 45 degrees, while the other shows the complete unit broken up into the component parts for man packing.

The construction of the cradle and gun tube are of a similar design to that described for the 37-mm. gun, except that the force of recoil is transmitted by suitable angles directly to the spade, thereby relieving the carriage proper of all firing loads.

The sight was originally placed on the right trail angle at a comfortable height for a man seated on the ground, as shown by the illustration, the trail being extended beyond the sight to protect it from damage should the carriage be tipped during traveling with the sight in position. This

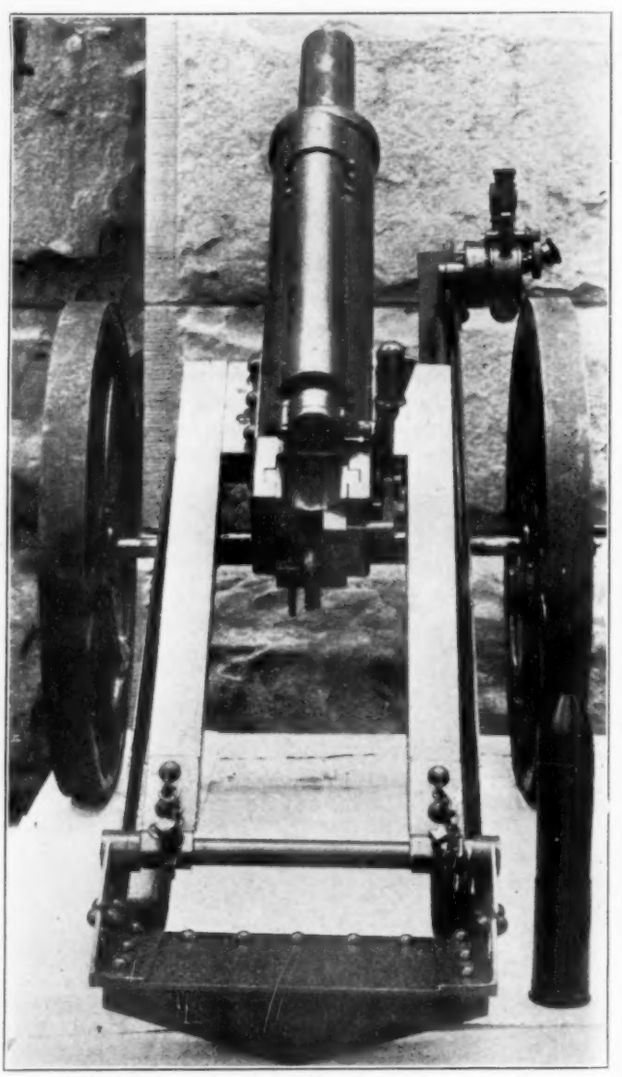


Figure 6

feature of the design, however, will be changed in the finished matériel, as it was an unnecessary refinement, and the sight will be located on the angle iron, which is attached to the recoil cylinder.

The elevation of this mortar is obtained by the use of a differential screw action between the recoil housing and the axle, the amount of elevation varying from 45 to 70

degrees. The traverse is obtained by rotating the axle in the wheels by the use of a suitable crank, which translates the entire top carriage about a pintle to which is fixed the spade. This feature has been introduced because of the tendency of the wheels to slide normal to the line of fire when traversing the mount.

2.24-Inch Infantry Mortar and Carriage, Model of 1923

The 2.24-inch Infantry Mortar and Carriage, model 1923E, are illustrated in Figures 5 and 6, and will be seen to be of the same general design as the 75-mm. Infantry Mortar and Carriage, with the exception that the pivoting spade has been eliminated, as it is believed that on the small spade necessary, there will not be sufficient ground resistance to cause the wheels to slide laterally. The final test alone can show the correctness of this assumption.

In the dismantling into the four component loads of the two above described weapons, the following procedure is necessary: First, the two taper pins are withdrawn from the cradle strut forks and trunnion bar. The cradle containing the cannon is then balanced horizontally upon the elevating mechanism, after which the front ring in the cradle is turned by means of a special spanner wrench, which unlocks the gun from the cradle, and the pin withdrawn, which disconnects the recuperator piston rod from the breech ring. The mortar tube is then withdrawn to the rear, and the cradle lifted off the elevating mechanism after the disconnecton of one additional pin.

The trail is disconnected from the axle by merely rotating it through 90 degrees, after which the axle can be disengaged, due to the nature of the special joint used.

Projectile	2.24″ Inf. Mortar, M. 1923E	75-mm. Inf. Mortar, M. 1923E
Weight of Shell, lbs.	6	12.12
Length of Case, inches	2.88	3.08
Length of Assembled Round, inches	11	12.6
Case Capacity, cu. in.	4	8
Charge weight, lbs.	.037	.07

Muzzle Velocity with 2.24″ and 75-mm. Infantry Mortars, M. 1923E	ft. sec.
1st Zone	450
2d Zone	395
3d Zone	350
4th Zone	310
5th Zone	275
6th Zone	245
Max. pressure in chamber	12,000 lbs. per sq. in.

	65°	45°
1st Zone	1,450	1,850 yds.
2d Zone	1,158	1,480 yds.
3d Zone	910	1,170 yds.
4th Zone	720	930 yds.
5th Zone	570	740 yds.
6th Zone	450	590 yds.

Zone Overlap min.	20 yds.
Length of recoil	10 inches
Type of recoil	Hydro-spring
Elevation of gun	45° to 65°
Total traverse (axle)	10°

General Characteristics.	2.24″ Inf. Mortar M. 1923E	75-mm. Inf. Mortar M. 1923E
Weight in firing position, lbs.	220	285
Diameter of wheel, inches	24	24
Width of wheel, inches	2	2
Ground clearance, inches	9	9
Gage, C. to C.	22	22
Weight of gun, lbs.	55	75
Weight of cradle, lbs.	60	70
Weight of trail and spade, lbs.	45	70
Weight of wheel, axle and elevating mechanism	55	65
Weight of sight, lbs.	5	5

Serial Numbers of Rifles, Pistols, Etc.

IN complying with General Orders No. 16, W. D. 1922, and as modified by General Orders No. 36, W. D. 1922, it was found in the Panama Ordnance Depot that as the reports of the serial numbers of rifles, pistols and other items were received from the various organizations, an enormous task presented itself in the compiling of these serial numbers in numerical order. This job seemed to assume even greater proportions when it was realized that it would be necessary to locate each individual piece as to company or battery and also make allowances for changes as they were sure to occur from time to time.

As outlined below, this entire job was completed at the Panama Ordnance Depot in less than two weeks time, in a most satisfactory manner and it is thought with the fewest chances of error possible.

First the reports from individual companies or similar units and post supply officers were assembled and each unit given a "key" number. Then a sorting machine was located and standard tabulating cards with certain special printing and column lines were used. Different colored cards were used for different items of equipment. This special color in addition to the name of the piece printed on the card helped in keeping the various items separate and avoided confusion Two columns were used on the card: one for the serial number and the other for the "key" number of the organization to which the piece belonged. The rest was easy. For example, the cards for the rifles were punched in the first column according to the serial numbers of the rifle and in the second column according to the key number of the organization and then put through the sorting machine. The same was done for the cards of each of the other kinds of equipment with the result that the cards came out neatly arranged in numerical order and were placed in trays suitable for filing and the job was done.

In operation it is only necessary to go to the cabinet of trays of these cards, pull out the drawer containing the wanted number or piece of equipment, look along the edge where index cards are placed according to thousands, and by referring to the original key list or guide, locate any rifle, pistol or machine gun in the department, even to its company or supply room.

With this record once established, it is a comparatively simple matter to record changes as they occur and the backs of the cards provide ample space for this or other history that may be desired.

War Production of the Saint-Chamond Company

By

Col. EMILE RIMAILHO

[The following article by Colonel Emile Rimailho, Director of the Technical Service of the Saint Chamond Company, indicates very clearly the difficulties involved in getting into production under war conditions, and illustrates some of the expedients to which the French government was forced in order to prosecute the war. No small part of the success with which the Saint Chamond met the demands upon it was due to the very able technical services of Colonel Rimailho.—ED.]

THE plants of the Saint Chamond Company developed before the war were specialized in product and located in different parts of France. The principal plant was the one at Saint Chamond.

Saint Chamond is situated in the Saint-Eteinne region, the centre of the French metallurgic industry. It had been the practice to manufacture there the more difficult parts of railway and ship matériel, and of artillery. Its products included armor plate, shell, cannon forgings, cannon, marine and land turrets, and heavy ingots and billets. It normally employed 3,500 hands.

Assailly, a neighboring factory employing 1,500 workmen, was specialized in fine steels, tool steel, springs, and gun-barrels. Due to its need of crucibles this plant built up an important business in refractory products.

Rive-de-Gier comprised forging plants for pieces of all sizes.

Le Boucau, at the mouth of the Adour, having four blast furnaces and Martin and Bessemer furnaces and rolling mills, utilized English coal and Spanish ores. It produced castings, rails and rolled products.

Finally, at Homecourt, situated in the centre of the "minette" basin in the vicinity of the Lorrain and German coal district, was built up a large and modern plant able to turn out a large tonnage and able to compete favorably with the best factories of our adversaries.

Hautmont, near Mauberge, in the midst of the industrial region of the north, specialized mostly in medium and small rolled products which the nearby mines and factories consumed.

After war was declared, Homecourt was immediately given up to the invaders; Hautmont was occupied as soon as the enemy arrived near Mauberge. There remained to the company only the factories of the Loire and Boucau.

Due to the mobilization, the above factories were depleted of their personnel and during one month, August 15th to September 15th, 1914, they operated only with a greatly reduced staff.

But when, during the last two weeks of September, the French troops' advance, after the Marne, was held up at the Aisne due to lack of artillery ammunition, Mr. Millerand demanded the reorganization of the company in the shortest time possible. Consequently, the workmen and engineers who had been mobilized were immediately demobilized and then began the gigantic effort to supply first ammunition and later all the other munitions required during four years of war.

The principal phases and most striking results of the efforts of four years will be summarized.

At the end of September, 1914, ammunition of all kinds was demanded for the supply of the 75's with the least possible delay, and in the largest possible quantities, as the stocks were completely exhausted.

It was necessary to have shells, cartridge cases, boosters and fuses.

Although the Saint-Chamond factory, like the Creusot, had always been one of the principal factories producing war munitions, and although it had manufactured for the French Artillery shrapnel and combination fuses, the supplies now needed were absolutely new to them.

Work was started immediately. In less than two months after the first order was received, components of ammunition for the 75s were being forwarded in large quantities. The quantities ceased to grow only when the General Headquarters found that they were not in need of increased capacity, and then the Minister of Armament demanded other products.

Mr. Millerand, the War Minister (as the Armament Ministry did not exist at that time) adopted, for the manufacture of munitions, the excellent idea of dividing France into industrial groups, and having in each group, at its head, an important factory, which co-ordinated the work of the group. The Saint-Chamond group included the manufacturers in the Saint-Etienne, Lyons and Grenoble regions.

In spite of all sorts of difficulties due to labor, to the supply of raw materials and of fuels, and to transportation, etc., remarkable results were obtained.

75-mm. Shells

In November, 1914, the Saint-Chamond group was forwarding 4,000 shells per day; four months later, in February, 1915, it supplied about 10,000; and one year later, in November, 1915, it delivered around 25,000 per day. The most striking thing was that all this was done with machinery and tools which were not intended for this sort of work.

While the industrial groups, which were organized in September, 1914, were able to take care of the most urgent needs, thanks to the conversion of machinery, there was time to create specialized plants for the manufacture of ammunition for the 75-mm. guns, and to equip them with American machinery.

The making of the 75-mm. shells at Saint-Chamond then became of secondary importance. There were many other needs to be satisfied.

Cartridge Cases

Until the outbreak of the war Saint-Chamond had never made any cartridge cases. These had been made in specialized plants. But as cartridge cases were required the Saint-Chamond Company started to manufacture them.

This is how it happened:

A train containing the facilities from Puteaux for making cartridge cases, which was evacuated when the Germans were nearing Paris, was side-tracked at the end of Sep-

tember between Saint-Etienne and Lyon. General Larange, who was then director of the plant, informed the Saint-Chamond Company of it and requested them to use the facilities and deliver cartridge cases to the Artillery with the shortest delay possible. At once a factory, being constructed to house a 1,500-ton press, was diverted for use in the production of this material. This change was effected in a few weeks. During the month of December, 1914, Saint-Chamond succeeded in delivering 30,000 cartridge cases. The production of this article continued to increase and reached about 200,000 cartridge cases, new and repaired, per month. This capacity could have been increased, but with change of policy of administration, the production of this article was assigned elsewhere.

Boosters

The manufacture of steel boosters was specially assigned to the Saint-Etienne region. Saint-Chamond furnished the material and directed their assembly. Here again the needs were quickly taken care of, and after having delivered 4,000,000 boosters, Saint - Chamond stopped manufacturing this article.

Fuses

Saint-Chamond manufactured fuses in peace time, and consequently it was quite natural that the administration charged them with organizing, as quickly as possible, the manufacture of fuses in large quantities. It is true that nearly everyone could manufacture boosters, and even shells, for the 75's, but the manufacture of fuses required a highly specialized personnel.

Their capacity was indeed small and could hardly take care of peace-time orders—500 fuses per day. This was little in comparison with the 100,000 the army required daily. The output was increased to 30,000 fuses during the month of November, 1914; 200,000 during the month of January, 1915; 1,100,000 during September, 1915, and 4,000,000 during the month of November, 1917. More than 100,000,000 fuses were delivered to the armies during the war.

Large Shells

After having stopped the enemy's advance, it was necessary to develop heavier munitions than the 75's to drive him out of entrenched positions. Consequently the manufacture of shells for 105, 120, 155, 220, 240 and 340-mm. guns was demanded.

In August, 1915, the delivery of larger shells than the 75's commenced with the supply of 1,200 shells for the 105-mm. Schneider gun. During the month of August, 1916, their capacity for shells larger than the 75's attained 40,000. When the Battle of Verdun started demands became more and more urgent and there were delivered 75,000 during March, 1916; 107,000 during May, 1916, and 150,000 in December, 1916, at the end of the Battle of the Somme. At this time output had finally reached requirements.

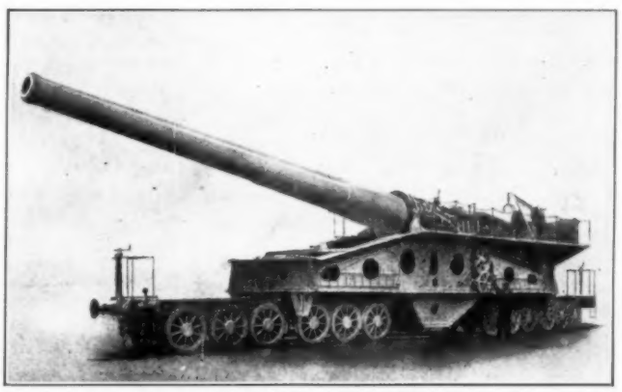
It must be remembered that during a war covering a period of four years it is not only necessary to manufacture shells but guns as well. This necessity seemed to be realized rather late. At the outbreak of the war the administration had stated that they had more guns than they required and that they wanted to cut down their stock.

Heavy Materials, A. L. V. F.

What was missing the most at the outbreak of the war in the way of artillery was the large caliber material, and Saint-Chamond here again rendered great service.

In November, 1914, the navy demanded the rapid construction of railway gun carriages for 305-mm. guns from battle ships. The answer was soon given and in less than 48 hours an agreement was reached. In one week the study under the supervision of Mr. Dupont was made, and 30 days after the order to start manufacturing was received, the first 305-mm. gun on railway mount was leaving Saint-Chamond on its way to Gavres for test.

After the 305 the 340-mm. gun was also mounted on a railway carriage, and after that the 400. Among the results obtained with the 400 was the destruction of the Fort of Vaux, which was regained without any loss of men, and the destruction of many tunnels, such as at Moronvilliers and the Chemin-des-Dames.



Saint-Chamond 340-mm. Railway Materiel, Model 1915

But notwithstanding the good results obtained with the heavy material it was necessary to replenish the stocks of the smaller calibers, such as the 75's and the 155's. The deficit in these smaller calibers had been caused by normal wear and also by destruction by enemy fire, and by prematures.

200 "Saint-Chamond" 75-mm. Guns

The time arrived when the company was asked to begin the manufacture of 75-mm. guns with the least possible delay. It is impossible to manufacture guns as quickly as shells. Besides, during peace time the company had never manufactured 75-mm. guns of the standard model. The drawings were considered "secret." Consequently, if that model were to be made, at least one whole year would be required to make special facilities and to get into production. Fortunately, they had a "Saint-Chamond" model of 75, of which they had already manufactured a certain quantity for foreign governments. An order was given for 200 guns, and six months after receipt of the order the first gun was delivered, and deliveries continued at the rate of 50 guns per month.

400 "Saint-Chamond" 155-mm. Guns

Although the order for the 75s had not been entirely delivered, the army was requesting 155-mm. quick-firing howitzers. The "Saint-Chamond" 155-mm. model which had been previously laid down for foreign governments was built and, after test adopted. A few months after the receipt of an order for 400, deliveries were being made at the rate of 50 per month.

Until the end of the war the company continued to turn out fifty 155-mm. howitzers per month, but of the "Schneider" model. This model was of a heavier design than the "Saint-Chamond," but a longer range was secured,

which, taking into consideration the special conditions of trench warfare, caused its preference.

200 145-155-mm. Guns

The 155-mm. howitzer, whether of the Schneider or Saint-Chamond type, had one disadvantage. Its range was too short to correspond with the German long 15-cm. gun. The Schneider long 105-mm. gun had a similar range but its projectile was too light. It was necessary to have a 155-long. Under these circumstances a 155 G. P. F. (Grande porteé Filloux) was adopted, which seemed to answer the purpose. But to build a gun of this description required a certain length of time, and once again Saint-Chamond was requested to fill the gap caused by the lack of this material.

A quick study was made by the company with the assistance of the navy, from which it was found feasible to mount on mobile carriages 14-cm. guns taken off ships, and thus obtain very quickly material sufficiently mobile and firing at 17 kilometers range projectiles of equivalent power to those used by the German.

Such is the origin of the 200 guns of 145-155-mm. caliber following 24 carriages mounting 14-cm. guns—which they were obliged to manufacture in great haste, with the assistance of Ruelle, while awaiting the supply in large quantity of the Filloux guns.

It is on these 145-155-mm. guns that the first experiments with reboring of guns were made. A long gun wears rapidly. After several thousand shots it does not fire as far as it previously did nor with the same accuracy as when new. As these guns are very expensive to manufacture it is a pity to throw them away on account of their being worn a millimeter or perhaps less.

But if they are manufactured with a bore 10-mm. smaller than their final diameter, they can be utilized until they are worn out, and then can be rebored to a larger caliber. This is a comparatively easy thing to do and a new gun results. This is the reason that these guns were manufactured with the caliber of 145-mm. It is understood that after they had been worn they would be rebored to 155-mm. caliber.

60 240-mm. Guns

The trench fighting proved that it was necessary to order guns of greater and greater calibers and longer and longer ranges.

At the outbreak of the war long range guns in calibers up to 340-mm. were ordered, but these were mounted on trucks and consequently depended on the railway for transportation. It was sure in an advance that in case of a rapid gain of ground by breaking the enemy's line the heavy guns would not be again available until the railway track could be rebuilt.

Headquarters, therefore, asked the Armament Ministry to supply them with 240-mm. guns firing at a very long range and able to travel on roads and fire on ordinary ground. At once Saint-Chamond presented a study showing the 240-mm. guns mounted on wheels, drawn by tractors, employing the old guns with trunnions and consequently being able to be fabricated very quickly.

This model was approved and an order given at once for 60 guns plus 60 more guns for reserve stock, and during the latter part of the war these guns gave the results which were desired.

400-Tanks—Electrified Locomotives

In addition to artillery the Saint-Chamond Company also contributed in a large way to the National Defence by the manufacture of tanks.

As soon as the results obtained on the battle field with the American "Holt Caterpillar" in passing over obstacles and going over the trenches were known, the Company immediately got in touch with the Armament Ministry and offered to manufacture quickly heavy tanks equipped with one 75 gun and several machine guns. This proposition was accepted, and 400 tanks of this model were delivered.

After the capture of Malmaison these tanks were used in every attack until the end of the war. They supplemented the Renault tanks in which was incorporated the experience acquired with the Saint-Chamond tank.

The Saint-Chamond tanks were unique in the employment of an electric transmission between the gasoline motor and the pinion driving the track. This system of transmission has always given the best results. It is easy to drive, has a large starting torque, and great ability to negotiate obstacles.

As in previous cases, when the small model of the Renault car had been adopted and the supply of the large tanks was judged sufficient, the manufacture of the Saint-Chamond tank was suspended. This same system of electric transmission was applied to the manufacture of the 200 gasoline electric locomotives of 60-cm. gauge and of 200 locomotives of the same system of standard gauge, which were used to haul near the enemy lines, without noise, smoke or light, the heavy railway guns. These models of locomotives gave excellent results.

Up to the present we have only spoken of the Saint-Chamond plant which in reality developed the maximum effort. The number of employees there before the war was 3,500; it reached 13,500.

At the same time the plants at Assailly and Boucau were not held at their ordinary peace time capacity. They also had more than doubled their usual personnel. At Boucau there were constructed new glass furnaces, several batteries of coke ovens, whose by-products were covered for use in the manufacture of explosives, open hearth furnaces; while at Assailly the installation of open hearth and crucible furnaces was increased and there was installed a forge shop for large and small caliber projectiles.

In addition to developing production capacity during the war the Saint-Chamond Company brought out several important inventions of munitions. These inventions were developed too late to be effective during the war but they are important in registering distinct progress in the development of artillery matériel. They are "Radiant" shell; mechanical fuses; hydro-pneumatic brake with variable recoil for the 75; track-laying matériel.

Radiant Shell and Mechanical Fuses

In spite of the good qualities attributed before the war to shrapnel, they have been almost completely abandoned or replaced in the course of the war by high explosive shell. The "Radiant" shell is an explosive shell which possesses in bursting the principal characteristics of the shrapnel; namely, the regularity in the shape of the fragments, of which there are a very large number. It is more efficient than the shrapnel on account of its superior ballistic qualities.

This shell is built up of rings of steel, the rings are perforated with holes, which are filled with steel balls. These rings are pressed tightly together and surround a tube filled with high explosive.

This shell explodes violently with the same order as high explosive shell, and breaks into about six times as many fragments as the ordinary high explosive projectile. Because of the regular form of the fragments as well as the balls, the radius of gun is greater than ordinarily obtained.

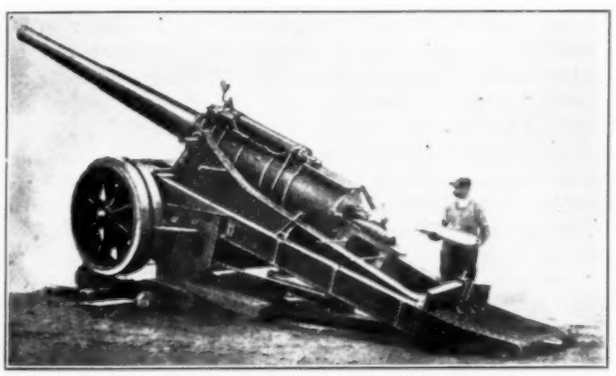
The properties of this shell are advantageous against

either immobile or slowly moving terrestrial targets, but are especially advantageous against aerial objects, for which it is necessary that the cone of fragments be not only dense but as uniform in pattern as possible.

As a result of the experiments carried on at Bourges, an order was placed for 100,000 of these "radiant" shells, but they were not completed before the end of the war.

In the ordinary time fuse the length of burning is regulated by a tube of powder, which is ignited while the projectile is still in the bore, and which after a certain length of time depending upon the setting of the fuse, explodes the bursting charge of the shell or shrapnel. This system, which is very good under normal conditions, is inaccurate for high angle fire. With the change in the density of the air the powder train burns irregularly or is often extinguished. Consequently the shell does not explode at the desired point, and sometimes not at all.

The mechanical fuse contains a time system something like a clock, in place of the powder train of the ordinary fuse. The functioning of the clock system does not vary with the altitude nor with the humidity. Its time range can be increased to any desired amount without increase in



Saint-Chamond 145-155-mm. Materiel, Model 1916

the outside dimensions and weight of the fuse, as is necessary in the case of the powder train fuse.

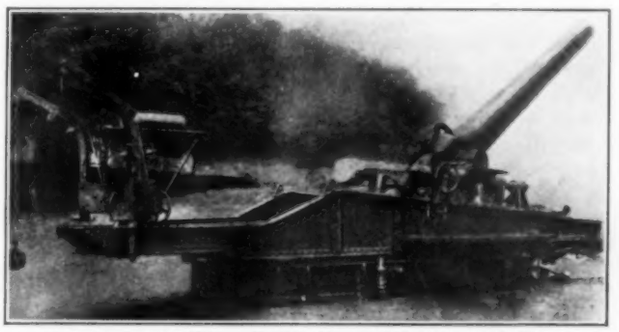
The mechanical fuse was the most difficult and delicate mechanism to perfect because of the stresses introduced by the high acceleration in the bore. However, with the aid of the Swiss watch makers, the mechanism was perfected and an order for 20,000 was completed, although deliveries were delayed until after the Armistice.

The price of the "Radiant" shell and of the mechanical time fuse is, of course, much greater than that of the ordinary shell and time fuse. However, if one considers the total value of all rounds required to accomplish certain results on aerial targets it will be found that the total expense will be less for the improved matériel than for the older form. This does not take into consideration at all the military advantage of utilizing the most effective gun fire against aviators.

Hydro-Pneumatic Brake

The French hydro-pneumatic brake for the 75 is well known, and gave complete satisfaction to the artillery. It then would appear to have been a waste of energy to seek to replace by a new recuperator the standard recuperator which functioned so perfectly during twenty years of peace and four years of war. This is why the new brake was developed.

When the United States entered the war they had a field piece known as the split trail, invented by Colonel Deport, and giving in battery position a field of fire of about 45° and an elevation of about 60°. This model, which had been adopted by the American Army after comparative trials, gave them complete satisfaction except for the recoil mechnism. They asked Colonel Rimailho, the Director of the



Saint-Chamond 240-mm. Tractor-Drawn Material, model 1916

Technical Service of the Saint-Chamond Company, who had assisted in the development of the French 75 and had developed the 155-mm. C.T.R., Model 1904, to make a study of a hydro-pneumatic brake for this matériel. This study was made under the authorization of the Minister of Armament and when this new brake was tested at Bourges it was found after firing 6,000 rounds not only that it worked entirely satisfactorily for the American matériel but that it had such qualities that it would be quite advantageous to substitute it for the regular recuperator of the French matériel. It was, therefore, adopted by the French artillery and was being put into production at Saint-Chamond when the Armistice was signed.

The following are its principal qualities: First, it uses many of the same interior parts as the 75 brake from which it was developed, especially the same piston rod and movable piston.

But while the former brake for the 75 operated with constant recoil for all elevations, the new brake varies automatically with the elevation; for small angles of fire it gives a long recoil, which is necessary to secure stability, while at higher angles of elevation it gives a shorter recoil, which permits the modification of the ordinary carriage for

Saint-Chamond 194-mm. Track-Laying Materiel, Model 1918

firing at high angles, and allows the gun to recoil between the flasks of the trail without digging at pit.

The new brake is easily demountable. In case of damage the piston can be changed in the field in less than one-half hour and without having to send the gun to the repair shops.

The new brake is of a simpler construction, and consequently more rapid than the standard brake. The com-

pany has built new field matériel both of the split trail and box trail type; both of them are equipped with this new Saint-Chamond brake, Model of 1918.

Saint-Chamond Track-Laying Materiel

To those who have seen tanks function upon shell torn fields and over obstacles thrown up by combatants, it appears highly desirable that especially heavy artillery pieces under certain special conditions should have practically the same mobility as tanks. Artillery officers also appreciate that the placing in position of a battery of heavy artillery, and putting it on the road, are always slow and difficult operations, and that when this work is done on soft ground the difficulties are greatly magnified. Artillery, therefore, of any or all calibers, and whatever its mobility over good roads may be, is rather immobile upon the battle field. Once it is in firing position, with its supply of ammunition, it is scarcely mobile at all. It is a difficult operation to move it. This is the reason why artillery is concealed and camouflaged. It appeared, therefore, particularly interesting, especially for calibers greater than the 75, to place the gun directly upon track-laying chassis, but it was feared that due to increased vulnerability the operations of placing material in and out of battery positions would really be rendered more difficult.

Saint-Chamond has solved this problem by using the chassis of the track-laying vehicle as the gun carriage. The gun, being mounted on the tractor, can fire as soon as the tractor is stopped, and can be put enroute just as soon as the last shot is fired.

A test was made of two types, the 120-mm. and the 220. The 220-mm. matériel was tried out on the rough ground of the "Park of Plessis de Roye," and negotiated the ground with extraordinary facility. One type of the same caliber, after inspection at Bourges, was experimented with on various sectors of the front, especially near Verdun, where the terrain is very rough. In the ravine of Vignes, where even 75's could not be maneuvred, these pieces were put into position and fired against German positions. Following these trials 75 mounts of this type, equipped with 194-mm. Filloux guns and with 280-mm. Schneider mortars, were requested by the army.

These were completed in spite of the intravention of the Armistice.

They combine opposing qualities of power and mobility, of great weight and ease of service, which had never been obtained nor even foreseen before.

This material consists of two separate units with electric transmission, but which operate as a single unit, each weighing from 20 to 30 metric tons according to the caliber (including 8 tons of ammunition, which is carried on the limber—this load alone normally requires three trucks), the whole forming a group which is heavy in appearance but in reality of astonishing mobility in negotiating terrain which is impossible by wheeled matériel. It can cross shallow streams, fields torn up by shell fire, trenches, break down walls, pass through forests, up-turning trees, with practically the same facility as tanks of the best model. As soon as the piece is stopped it is ready to fire, with ammunition along side, and without any special maneuvering or any special preparation of the ground, and in any direction.

The electric transmission permits the location of the gasoline motor on the limber, the gun being mounted on the second vehicle. Thus if the enemy fire becomes too severe the limbers may be withdrawn to the rear, as in the case of horse batteries. This reduces to a minimum the vulnerability of the matériel exposed to enemy fire. If, however, the enemy locates the position of these self-propelled batteries, either by sound ranging apparatus or by aerial reconnaissance, it is possible to remove them, together with their ammunition, in a few minutes, before the enemy fire becomes effective. They may be again emplaced 200 metres distant without any great interruption of fire, thus baffling the enemy's plans.

As projectiles weighing from 90 to 270 kilos are used, with ranges from 10 to 20 kilometres, this self-propelled artillery constitutes a powerful matériel for bombardment.

What is the future of this self-propelled matériel? Does this construction apply only to the large calibers and very heavy cannon, or is it suitable to all calibers, even the 75? This question must be decided by the artillery but it seems worth while to state that the Saint-Chamond Company had, during the war, not ignored this great problem of mobility of artillery upon the battlefield, and had developed matériel which, together with its ammunition, would follow the infantry however rapidly it advanced.

The above briefly summarizes the work of the Saint-Chamond Company during the war, both in the production and development of matériel. These results are the more remarkable as at the beginning of hostilities two of their largest and most modern plants were lost to the enemy, and as the remaining plants had to be developed to satisfy the needs ordinarily filled by the lost plants.

German *vs.* U. S. Artillery

By O. L. GARVER

THE object of this article is to give a brief discussion and comparison of our own artillery with that used in the German army.

In 1914, at the beginning of the war, Germany had one hundred and ten different models of carriages—of designs which were acceptable. Their light, or divisional, artillery consisted of 77-mm. guns and 105-mm. howitzers; their Corps Artillery of 105-mm. guns and 150-mm. howitzers, and their Army Artillery of 150-mm. guns and 210-mm. howitzers.

The light gun carriage with which the greater part of the army was equipped in 1914 was the 77-mm. Gun Carriage Model 1896 NA. This was a conventional type, box trail carriage, with a spring return recoil mechanism, a dependent line of sight, and a maximum elevation of but 16 degrees.

In 1916 they brought out the 77-mm. Gun Carriage, Model 1916. This was distinguished from the 1896 NA by a longer gun and a carriage similar to that for the 105-mm. howitzer, making it possible to obtain 40 degrees elevation and a greatly increased range. This carriage had the trunnions at the breech of the gun and was provided with equilibrators. These carriages were considerably superior to the 1896 NA as is shown by the fact that in the early part

of 1918, 58 per cent of the 77-mm. guns in use were of the new model.

For howitzer matériel to accompany the light field guns, Germany had at the start of the war the 105-mm. howitzer, Model 1898-09. This was a box trail carriage, with trunnions at the breech and equilibrator between the cradle and trail, thus allowing constant recoil at all elevations. Separate loading ammunition is used and the howitzer can be loaded at any angle of elevation.

There was developed and put into service during the war a 105-mm. howitzer, Model 1916. The carriage is similar to the preceding but the howitzer is much longer, giving increased muzzle velocity and range.

In Corps Artillery, the war was started with two models of 105-mm. Gun Carriage, the 1904 and the 1914. The latter, which mounts the more powerful gun, was a box trail carriage fitted with both a fixed and a folding spade. The trunnions are located near the breech, requiring the use of equilibrators. This is one of the few German carriages using a hydro-pneumatic recoil mechanism.

During the war there was developed and put into service the 105-mm. Gun Carriage, Model 1917, a very much more powerful gun, mounted on a carriage which was in all essential features similar to the 1914 carriage.

The Corps howitzer, 150-mm. caliber, consisted of the 1896, 1902 and 1913 models. These were all of similar type, having box trails, quick return mechanisms and hydro-pneumatic recoil mechanisms. The length of recoil is variable and is regulated by the recoil of the piston during elevation. These howitzers are not balanced about the trunnions and are fitted with equilibrators.

There was a Model 1917 howitzer carriage brought out during the war which was almost identical in construction to the older types, but which mounted a slightly more powerful howitzer.

The guns of the Army Artillery were of 150-mm. caliber. The carriage for this gun was similar to the other pre-war carriages, having a box trail, dependent line of sight, trunnions near breech with equilibrators to overcome the muzzle preponderance and a constant recoil, hydro-spring recoil mechanism.

There was put into service during the war the 150-mm. Gun Carriage, Model 1916, of Krupp design. This was a much more powerful weapon than the pre-war one, the gun being 40 calibers in length. The carriage was of the general type of the preceding but was equipped with an independent line of sight. These two carriages differ from the lighter carriage in that they are equipped with cast steel wheels in place of wooden wheels.

The predominating Army howitzer was the 210-mm. howitzer carriage, Model 1911. This carriage was used throughout the war with practically no change. It is a conventional type carriage with a hydro-pneumatic recoil mechanism, box trail, equilibrators, and is fitted with wheels of pressed steel construction.

Germany had several guns and howitzers in service for which there are no corresponding calibers in the United States service, notably the 305-mm. and 420-mm. howitzer and the 130-mm. guns. These do not differ materially from other German carriages with the exception of the 305 and 420-mm. howitzers, which are removed from the wheeled carriages and placed on platforms for firing.

The tables give a comparison of the general characteristics of the artillery of the two countries, both before and during the war. The brackets at the top of the columns show corresponding calibers. (Continued on Page 172)

GUN {GERMAN OR U.S MODEL	U.S. 1897MI	U.S. 1917	GER. 96 N/a	U.S. 1902	GER. 1904	GER. 1914	GER. 1910	U.S. 1906	GER.
CALIBER	75 M/M	75 M/M	77 M/M	3. IN.	105 M/M	105 M/M	130 M/M	4.7 IN.	150 M/M
WEIGHT OF GUN (LBS.)	1015	995	860	788				2688	7420
MUZZLE VELOCITY (FT./SEC.)	1805	1750	1526	1700	1835		2280	2050	1640
MUZZLE ENERGY (FT./TON.)	275.09	258.58	256	301	926			1204	1790
MAX. ELEVATION (DEG.)	19	16	16	15	30	45		15	40
MAX. DEPRESSION (DEG.)	-10	-5	-6	-5	-5	0		-5	-4
TOTAL TRAVERSE (DEG.)	6	8	7	8	7°-52′	7°-52′	20	8	7
LENGTH OF RECOIL (INCH.)	44.9	41		46			53.1	70	
LENGTH OF GUN (CAL.)	34.5	28.4	27.3	28	28.4	28.8		27.5	30
RANGE (YDS.)	6800	5900	9260	6000	12700	13100	15748	8000	13100
BREECH MECHANISM (TYPE)	SCREW	SCREW	WEDGE	SCREW	D.BLOCK	WEDGE	WEDGE	SCREW	WEDGE
HEIGHT OF BORE (INCH.).	40.4	36.8		40.8				51.7	
RECUPERATION {HYDRO.-SPRING HYDRO.-PNEU.	HYD-PNEU	HYD-SPR.	HYD-SPR.	HYD-SPR.	HYR.-SPR.	HYD-PNEU.		HYD-SPR.	HYD-SPR.
TRAVERSE {AXLE PINTLE	AXLE	SCREW	WEDGE	SCREW	WEDGE	PINTLE	PINTLE	PINTLE	PINTLE
WEIGHT OF {SHELL OR SHRAPNEL	12.3 16	12.4 16	15.8 15	15	39.6	39.6		45 60	96
LINE OF SIGHT {DEPENDENT INDEPENDENT	IND.	IND.	DEP.	DEP.	DEP.	DEP.	DEP.	DEP.	DEP.
KIND OF SIGHT {PANORAMIC GONIOMETERIC TELESCOPIC	COLLIMATR	PAN.	PAN.	PAN.	PAN.	PAN.	PAN.	PAN.	PAN.
DIA. OF WHEEL (INCH.)	52.5	56	53	56			55.2	60	55.2
WIDTH OF TRACK (INCH.)	59.6	60	60	60			60	60	60
WEIGHT OF GUN & CARR. FIRING POSITION (LBS.)	2657	2887	2161	2520	6380	6120	12787	8068	13440
WEIGHT OF CAISSON & LIMBER (LBS.)	4570	4570	4094	4595	6000		6800	9112	
NO. OF LOADS GUN & CARRIAGE	1	1	1	1	1	2	1	1	1

General Characteristics, U. S. and German Artillery at Entrance of the U. S. in the War—Guns

Fourth Annual Meeting *of the*

Aberdeen Proving Ground

THE Fourth Annual Meeting of the Army Ordnance Association, which was held at the Aberdeen Proving Ground on October 6, 1922, attracted a number of scientists, engineers and manufacturers of the country closely approximating one thousand. The continuing interest and enthusiasm evidenced by the members of the Association in regard to their annual meetings is intensely gratifying to everyone who is convinced of the supreme importance to the United States of the question of industrial preparedness. Year after year the programs of firings and demonstrations of ordnance matériel, showing the progress the Army Ordnance Department has made along the lines of ordnance development, are witnessed by great numbers of industrial engineers and manufacturers who are thoroughly in accord with the professed aim of their Association, which is to "Effect Industrial Preparedness for War as our Strongest Guarantee of Peace."

This year the meeting was especially interesting and well arranged and much credit was due the Commanding Officer of the Proving Ground and his staff for the efficient manner in which all details were handled.

In the *Washington Post* of October 7, 1922, the meeting was described as follows:

Postwar developments in ordnance that are considered engineering marvels in the science of warfare, were demonstrated yesterday at Aberdeen, Md., Proving Grounds before members of the Army Ordnance Association, affiliated engineering societies and manufacturers who have consented to convert their plants in event of war.

New or improved devices for defense or offense, on land, sea, or in the air, were constant sources of amazement as their exhibition followed each other in rapid succession.

At intervals throughout the day the air shrieked with shells, some of them with fuses so sensitive they would explode at the slightest impact. The practical value of this invention was demonstrated when such shells were seen to detonate as they passed through pieces of airplane linen suspended as targets. As anti-aircraft munition, these shells would be successful in bringing down a plane if they only brushed a wing, it was said.

Others with less sensitive slower-timed fuses were seen to penetrate 16 inches of armor plate and explode. These missiles can be projected with accuracy and effectiveness over a range of 26 miles and rise 10 miles in the air in their trajectory. They were designed primarily for coast defense against battleships, but could be used effectively on land for bombarding cities. The shells could pass over the highest mountain.

Planes circling 8,000 feet overhead dropped various sized bombs, the largest of which, weighing 2,000 pounds, tore a crater of about 50 feet in diameter and 40 feet in depth in the ground. The time of the fall was about 23 seconds and the fuse was set so as not to explode for several seconds after impact. A bomb of this sort if dropped on the Woolworth Building, would penetrate almost to the first floor and wreck that structure.

Thirty and .50 caliber machine guns charged with armor piercing projectiles and mounted in a moving tank, riddled an old Renault tank, which was used as a target. Another

THE WHITE HOUSE
WASHINGTON

September 21, 1922.

My Dear Colonel CROWELL:

The very lively interest I have felt in the work and the purposes of the Army Ordnance Association from its beginning adds to the regret with which I have to say that there is little prospect of my being able to accept your invitation to the Annual Meeting on October 6.

I feel that this organization is worthy of every encouragement and wish I could make it possible to accept your invitation and be with you at the forthcoming meeting. Please convey to the members who will gather at that time the assurance of my interest and also of my conviction that they are carrying forward an effort in the field of industrial preparedness which is of the very greatest importance to the country.

Most sincerely yours,

WARREN G. HARDING.

Hon. BENEDICT CROWELL,
Room 410, Munsey Building,
Washington, D. C.

Army Ordnance Association

October 6, 1922

tank, with crew entirely concealed, went through the most intricate maneuvers, guided solely by orders given over radio-telephone by an officer in another tank.

An amphibious reconnaissance tractor, with boat-shaped body, was one of the most interesting after-the-war developments exhibited. It proceeded over rough ground at a speed of 12 miles an hour and upon reaching a waterway too deep to ford went afloat and continued to the other side by means of screw propellers. A self-propelled, shell-carrying tractor designed to carry ammunition up to the front lines when no roads are available was shown. The operator walks behind in order to make the full capacity of the vehicle free for the carrying of ammunition. Toy balloons were released as targets and quickly brought down with a barrage of machine-gun fire. The feature of this event was the use of phosphorus tracer bullets, by means of which the bullets could be followed in their flight, and the fire more accurately directed. These bullets are also effective for night engagements.

The night session was occupied with a demonstration of flashless powder in a .75-millimeter gun and 155-millimeter howitzer, which, in firing, gave no evidence of their location other than the report. Flares having the power of 10,000 ordinary electric lamps, and burning for 7 or 8 minutes, were dropped from airplanes and lit up the range with a ghastly figure.

In the Washington *Evening Star* of the same date the meeting was viewed from a slightly different angle:

A whippet tank which went in any direction and performed the most intricate maneuvers, guided solely by radio; the geyser-like explosion and volcanic roar of a 2,000-pound bomb dropped from an airplane, and a demonstration of the new 16-inch gun carriage which permits such a gun to be pointed and turned almost as quickly as the movie gun-man handles his 6-shooter—these were some of the marvels of modern war shown yesterday at Aberdeen Proving Ground. * * *

Phosphorus tracer bullets, fired through an airplane propeller over the proving grounds, showed how an airman can correct his aim in war. To illustrate the difference between instantaneous and delay action fuses bombs were dropped from airplanes into the water from a height of 4,000 feet.

Firing of 12 and 8-inch guns from the Army railroad carriages was one of the most interesting features of the exhibit. A 50-caliber 14-inch gun on railway mount was recently completed at the Watertown Arsenal and represents the most powerful railway ordnance in existence. * * *

WAR DEPARTMENT
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON

Honorable BENEDICT CROWELL, October 10, 1922.
President, Army Ordnance Association,
Washington, D. C.

My Dear Mr. CROWELL:

I wish to congratulate you on the excellence of the Fourth Annual Meeting of the Army Ordnance Association, held at the Aberdeen Proving Ground on October 6.

It was an extremely well arranged and well executed affair and one which it gave me great pleasure to attend. The demonstration of ordnance material and the program of firings were extraordinarily interesting, and I feel that the Chief of Ordnance and his officers deserve the utmost credit for the progress they have made along the lines of ordnance development.

It is a continuing satisfaction to me to observe the genuine enthusiasm that is shown by your members, and it must be evident to anyone who has attended one of the Annual Meetings that both the Army Ordnance Association and the Ordnance Department are engaged in a work that should be of vital interest and value to all of American industry.

Assuring you of my earnest desire to co-operate with you in your splendid efforts to secure the industrial preparedness of the country and of my keen interest in the success of the Army Ordnance Association, I am,

Very sincerely yours, J. M. WAINWRIGHT,
The Assistant Secretary of War.

The *Washington Times* of October 7, 1922, had an account of the meeting in part as follows:

A projectile fired from a 16-inch gun screamed into the air more than two miles higher than the greatest altitude ever reached by an airplane and traveled 26 miles to its destination at the Army Ordnance tests today. Then after ascending 10 miles it had speed enough left to pierce 16 inches of hard steel.

Its course across Chesapeake Bay was cleared of all shipping, airplanes were kept out of the sky thereabout, and a thousand spectators on the ground, their ears stopped with cotton, stood on tip-toe to minimize the shock of the detonation to their nervous systems.

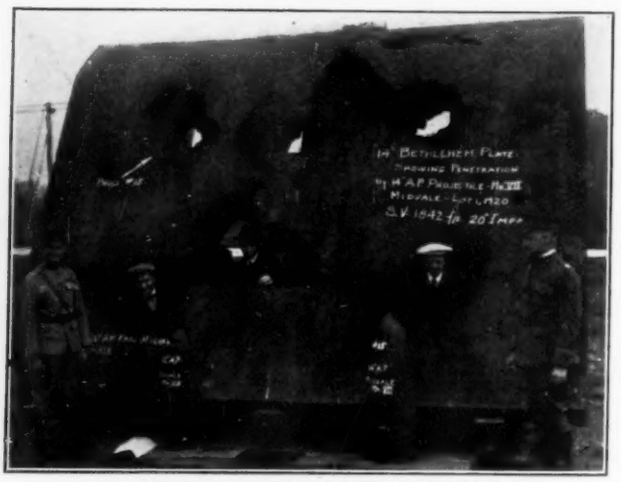
Then a ton-weight bomb was dropped from an airplane a mile and a half in the air. When it struck it dug a hole in the ground 40 feet deep, exploded by means of a delayed fuse and made a crater 60 feet wide.

A supersensitized shell that withstands the shock of firing

as it leaves the gun but bursts on contact with the fabric of an airplane wing was demonstrated. This is the newest wrinkle in anti-aircraft warfare.

The coast defense experts were interested mainly in a 14-inch gun which can be moved by train up and down the coast—either coast—and send a projectile 23 miles out to sea. * * *

This gun could be mounted on a railway train behind the Sierra Nevada mountains in California, send its projectile over the mountain and against the side of an invading battleship in the Pacific 23 miles away; 500 pounds of powder are needed to fire the shot.



Armor-Piercing Projectiles and Perforated Plate

Other new developments in modern warfare demonstrated today were:

1. An amphibious tank, used for scouting, operable either on land or water.
2. Tanks controlled by radiophone.
3. Tank-piercing shells exploding inside the tank and destroying its effectiveness.
4. A machine gun firing 600 shots a minute over a 5-mile range.

After dark an airplane released a number of parachute flares which lighted up most of the Aberdeen Proving Grounds for more than five minutes. * * *

Program of Firings in Detail

The first portion of the demonstration was at the Railway and Seacoast Range. This included the firing of one round with 16-inch gun on barbette carriage at high angle using the Solenoid Chronograph; maneuvering the 16-inch gun in elevation and azimuth by hand and by power; exhibit of armor-piercing projectiles which had passed through armor plate and showing the penetrated armor plate; maneuvering and firing of 14-inch railway mount; firing of one round from 12-inch howitzer on railway mount; firing of one round from 8-inch howitzer split trail carriage, model 1920; a machine gun barrage and rifle phosphorus grenade barrage fired on the water area.

At the aviation field, which was the next point visited, there was an extremely interesting exhibition of all types of American bombs and all available types of foreign bombs. There was also an exhibition of machine gun firings from a DH4B airplane on the ground so that details were visible. Firings were also made with the plane in the air. There was an inspection of the airplanes and dirigible balloon on hand at the Proving Ground and flights were made after the inspection.

The party then entrained on the Proving Ground railroad and proceeded to the Visitors' House for luncheon, which was served at 12:45 p. m. Immediately after luncheon came the exhibition at the Main Front, where the following matériel was shown:

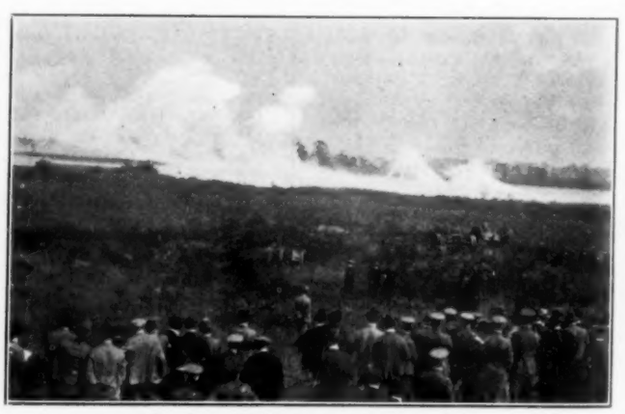
Mobile Artillery Materiel

37-mm. gun, model of 1917,
3-inch gun matériel, model of 1902,
75-mm. gun matériel, model of 1897 MI,
75-mm. gun matériel, model of 1916,
75-mm. gun matériel, model of 1917,
75-mm. gun matériel, model of 1920 E,
75-mm. gun matériel, model of 1921 E,
2.95-inch Vickers-Maxim mountain gun,
75-mm. pack howitzer matériel, model of 1920 E,
105-mm. howitzer matériel, model of 1921 E,
4.7-inch gun matériel, model of 1906,
155-mm. howitzer matériel, model of 1917.
4.7-inch gun—155-mm. howitzer matériel, model of 1920,
8-inch howitzer matériel, Mark VI,
3-inch anti-aircraft gun, 1920, on trailer mount,
4.7-inch anti-aircraft gun, 1920, on Christie mount.

Rounds were fired from certain of the above matériel for comparison as follows:

5 rounds 37-mm. H. E. super-sensitive fuse against 2 layers airplane linen 4 inches apart. The high explosive in these shells was replaced with black powder as a safety precaution,
5 rounds 3-inch anti-aircraft gun, model 1920, on trailer,
5 rounds 4.7-inch anti-aircraft gun, model 1920, on Christie mount,
1 round 155-mm. G. P. F., model 1920, on S. P. mount, Mark IX,
1 round 3.3-inch matériel to show yaw,
Trace trajectory with 75-mm. gun shrapnel,
5 rounds 75-mm. gun, 1920, split trail,
5 rounds 105-mm. howitzer, 1921, box trail,
6 rounds 155-mm. G. P. F., using Du Pont "Nitrotite" containers.

Firings were also conducted from machine guns mounted



Bursting of Rifle Phosphorus Grenades

in a moving tank, the target being an old tank on the Main Range.

There was a small arms exhibit at which were shown the latest types of small arms and machine guns and their ammunition. Machine guns of various calibers were fired with ordinary ammunition, armor-piercing ammunition and

bursts of tracer ammunition. Firings of the .30-caliber and 11-mm. were made against free toy balloons and of the .50-caliber against a tank.

There were dropped from planes one 2,000-lb. bomb for function test from an altitude of 8,000 feet and two 600-lb. Mark I MI. bombs equipped with Mark V and VII nose and tail fuses, one fuse set for instantaneous function and the other for delay action.

As soon as the firings outlined above had been completed the following self-propelled mounts, tanks, tractors and trailers were exhibited and maneuvered:

Motor Carriages—

Mark III for 240-mm. howitzer (Schneider),
Mark IV-IVA for 240-mm. howitzer (Schneider),
Mark VII for 75-mm. gun,
Mark IX for 155-mm. gun—8-inch howitzer, model 1920 E,
Christie for 155-mm. G. P. F. Gun.

Tractors—

Best "30" towing 4.7-inch gun, model 1906,
Holt T-35 towing ¾-ton trailer,
Holt T-29 towing 75-mm. gun,
Pavesi (Italian) towing Christie 3-ton trailer,
2½-ton tractor, model 1918, modified with Class B truck motor,
Fordson with Hadfield-Penfield adapters,
600 and 900-lb. power carts,
800-lb. reconnaissance tractor.

Tanks—

Medium "A" tank,
Mark VIII with stroboscope,
Radio-directed Whippet tank,

Upon completion of the demonstration at the Main Front, the party were conducted to the Exhibition Building for the purpose of inspecting the various automotive vehicles and other equipment in the building. This concluded the daylight program and at about 5:45 the party proceeded to the Visitors' House for dinner. They then proceeded to the Main Front, where there was a demonstration of flashless powder in the 75-mm. gun and 155-mm. howitzer; .30-caliber tracer ammunition; 11-mm. tracer ammunition; .50-caliber tracer ammunition; 3-inch shrapnel fitted with night tracers, and of pyrotechnics.

Immediately after this firing the Proving Ground train left for Aberdeen to make connections North and South for visitors returning home.

Among the many distinguished members of the Association present at the Fourth Annual Meeting were the Assistant Secretary of War, Mr. J. M. Wainwright, the former Assistant Secretary of War, Mr. Benedict Crowell, now President of the Army Ordnance Association and General W. S. Peirce, Acting Chief of Ordnance.

Effect of 2,000-Pound Bomb

As part of the program at the recent meeting of the Army Ordnance Association two 600-pound Demolition Bombs and one 2,000-pound Demolition Bomb were dropped on the main range of the Aberdeen Proving Ground from airplanes flying at an altitude of 4,000 feet.

Those who witnessed this part of the demonstration were no doubt impressed by the tremendous detonation of the 600-pound bombs and somewhat disappointed by the relatively insignificent detonation of the 2,000-pound bomb. Spectators standing on the concrete road at the main front, however, realized that the functioning of the two types of bombs was quite different, for in the latter case, although the visual and audible effects were small, a quite perceptible ground tremor accompanied the detonation.

Exterior Walls of 2,000-lb. Bomb Crater. Road Completely Blocked

Unfortunately only those few persons who followed the road down the main range to the crates were able to see the actual effect of the bomb. The road was blocked by a high bank of earth which on closer inspection proved to be the walls of a crater approximately 40 feet in diameter and 18 feet deep. The accompanying pictures attest the power of the bomb. Both the lack of noise and earth vibration were due to the long delay caused by the use of a 1.2 seconds delay fuse. This permitted the bomb to penetrate at least 25 feet in the ground, thus muffling the noise of the detonation. The bomb passed through a considerable thickness of dense, hard-baked, red clay and entered the quick-sand below ground-water level before functioning. This was indicated by the presence of sand on the walls of the crater and also on the ground outside. One effect not hitherto observed in bombs was made evident by the detonation of this 2,000-pound bomb near the road. On both sides of the crater for a distance of at least 60 yards there were observed to be irregularly spaced cracks in the road which were concentric with the crater. These cracks further confirmed the evidence of the quick-sand that the bomb had detonated below ground water, which had transmitted the force of the explosion to a considerable distance.

Interior of 2,000-lb. Bomb Crater
Note large stump of tree uprooted by detonation. Water in bottom is quick sand level.

Dinner of New York Post

Left to Right: Col. H. B. Ferguson, Col. John Ross Delafield, Gen. W. S. Peirce, Gen. James G. Harbord, Hon. John W. Weeks, Gen. Guy E. Tripp, Col. J. Mayhew Wainwright, Gen. R. L. Bullard, Maj. F. C. Bull, Gen. Wm. Weigel, Gen. Peter Murray, Col. J. W. Joyes, Maj. M. L. Brett.

Dinner *of* New York Post, A. O. A.

Monday, October 23, 1922

On Monday evening, October 23, 1922, the New York Post of the Army Ordnance Association gave a dinner at the Army and Navy Club in honor of Colonel Delafield, the new chief of the New York Ordnance District. Over two hundred members of the Post attended the dinner. The guests of honor included the Secretary of War, the Assistant Secretary of War, Major General James G. Harbord, Major General R. L. Bullard, Brig. Gen. W. S. Peirce and Brig. Gen. Guy E. Tripp.

After the dinner, the Secretary of War spoke most earnestly on the subject of Industrial Mobilization. His speech is reprinted in full in this number of Army Ordnance. Following him the Assistant Secretary of War made an address, which was, in part, as follows:

One of the great difficulties experienced in meeting the supply problem in the last war, besides those which arose from the absence of any plan to supply ammunition needs, was the lack of concentration of control or unity of authority with regard to procurement. Each service appeared to proceed with reference to its own needs without regard to the others. There were literally too many cooks and they came near spoiling the broth. The consequent confusion and lack of co-ordination and co-operation probably cost us dearly in time and money. To obviate that situation in the next emergency, Congress reposed the authority and the responsibility to provide an adequate plan of procurement and to supervise the procurement activities of the War Department in peace as well as in war upon the Assistant Secretary of War, under the direction, of course, of the Secretary of War. With a full realization of the great responsibility of the task, we have been for a year and a half working on a plan and trying to effect the necessary organization. As you are aware, a procurement section has been organized in my office and there are now a group of officers in each of the procurement branches giving all their time to a study of the problems of their department and to the formulation of plans to meet their requirements in case of war. Under the able leadership of my chief of procurement, Colonel Ferguson of the Engineers, assisted by Colonel Hunt of the Q. M. C., and Major Brett of the Ordnance, this work is well advanced. The great problem in the next war will be, as it was in the past, with regard to ordnance as munitions of war.

The industrial war plan of the Ordnance Department is probably further advanced than any of the others, and this has been due probably largely to the loyal and patriotic co-operation of the Ordnance Association. . . . May I express my thanks and congratulations to General Tripp and all other former Ordnance officers and civilians for their devoted interest in this work? It is largely through their initiative that we now have a definite organization in each of the ordnance procuring districts into which the country has been divided. And may I express our great gratitude to my chief, the Secretary of War, for the unfailing support he has given us, for without that support plans could not even have been initiated. And to General Harbord, our Deputy Chief of Staff, with whose great service to his country as Chief of the Service of Supply in France we are all familiar, for his co-operation, for under his direction the General Staff have formulated a program for all branches so that all are working to a common end, thus avoiding the confusion created in the war by the diversity of programs with one branch working on a basis of five thousand men and another on one for five million. Colonel Delafield has consented to act as the Chief of Munitions Procurement in this the most important of all districts. It is a great relief to find a man willing to assume this huge task, for the task of each of the district supply chiefs is equal to the entire procurement task of the Civil War. To each of you others here present may I express my appreciation of your interest and offers of assistance. With the advice of the older members and with some real work on the part of the younger men, we may confidently look forward to the crystallization of a real plan with competent men to work it. The organizations in the other branches are progressing satisfactorily and I hope that there will be a close contact and mutual understanding of the respective tasks of the bureaus.

Questions that may arise between the branches can be settled in the Department and the members of the planning branches of all are in close contact.

The Contract Board, under the Chairmanship of General Peirce, has made great progress and formulated a uniform form of contract which has been highly approved by many contractors and manufacturers who dealt with the Department in the late war.

The sympathetic assistance and co-operation everywhere has been most gratifying. We have conferred with Mr. Baruch and many of his associates of the War Industries Board, such men as Mr. Stettinius, Mr. Scott and Mr. Crowell, my able predecessor, through whose efforts and courageous insistence the present law was passed.

Questions between the Army and the Navy will be obviated

by the joint munitions board, consisting of the two Assistant Secretaries.

We have called on and received the co-operation of other Departments and Bureaus, such as the Department of Commerce, the Bureau of Mines and the Geological Survey. We have taken advantage of the offers of assistance of the technical societies, such as the Mechanical Engineers and Automotive Engineers. Engineers familiar with power problems are working in conjunction with the district officers of the army.

The Mining Engineers have appointed permanent committees to confer with ours.

I have conferred with representatives of many trade associations and they have offered us their best assistance in distributing the war load as soon as our requirements are ascertained.

The ground work, I feel, is sound and with our requirements figured I believe we will be able to formulate a practicable and workable plan which can be varied to meet any definite emergency which may arise. We are doing all that can be done under the authority of the War Department, but of course there are many problems which are beyond our Department, such as strategic materials not produced in the United States, how we are to keep up our deteriorating reserves, problems relating to the Air Service so dependent on the development of commercial aviation, and how we are going to keep our trade routes open—but with your assistance and that of such as you, I believe we can find effective solution for these problems.

Gentlemen, I believe we are building better than we know and that in the end we can develop a real industrial war plan which will contribute vastly to the security and defense of our beloved country if we should have to meet the emergency of another war.

General Harbord spoke on unpreparedness, in part as follows:

I take it that it is a matter of common knowledge with this audience, as it is with professional soldiers, that two facts stand out as demonstrated by the World War.

1. It was a war by whole peoples and not by armies and navies alone.

2. The importance of materiel, infantry rifles, machine guns, field and railroad artillery, the whole mechanical side of war, increased beyond all past history.

These facts are closely related, and they are but the military phase of the industrial evolution which has been changing the organization of society since the introduction of power-driven machinery. This process of change will go on as long as our civilization endures, and military science if it is to survive must keep the step. That our country is not unmindful of all this is shown by the organic act of June 4, 1920, under which the War Department is now functioning. For the first time in our history we have a definite military policy, in sharp contrast to the policy of drift which has controlled our destiny for nearly a century and a half, and cost us untold thousands of lives and many millions of dollars.

The provision of the Act referred to, which is of chief concern to the industrial life of the country, and therefore of chief interest to you gentlemen, is that which assigns to the Assistant Secretary of War, the "supervision of procurement of all military supplies, * * * and the assurance of adequate provision for the mobilization of material and industrial organizations essential to war time needs." With this and because of it, goes the related co-ordination of the efforts of the several supply services of the War Department in their procurement activities. The uneo-ordinated activities of these services, as well as of other governmental agencies—the Navy, the Shipping Board, the Railroad Administration, and a thousand enthusiastic commissions of various kinds are fresh in the memory of all of us. In that crowded summer of 1917 in France, one of the most time-consuming, patience-exhausting duties of the Commander-in-Chief was to line up and bring under control the many well-meaning, ineffective American Missions, of both sexes, who infested Paris. The Powers conferred upon the Assistant Secretary of War by the Act of 1920, are intended to prevent any such confusion of military and industrial effort in future emergencies, as far as the various procurement branches of the War Department are concerned. The military side of the War Department is keenly alive to the great importance of this work, and earnestly supporting it in every way. A nation prepared only in the military phase of war to the neglect of industrial preparedness is for modern war a nation unprepared.

The District office system grew out of the necessities of the situation created by the enormous procurement plan of the Ordnance Department during the war. In the early days of the war, Ordnance Procurement was controlled from the Ordnance Office in the War Department. All munitions makers had to communicate with Washington by letter, telephone, telegraph, or in person to get decisions on daily recurring questions of contract interpretation, engineering and shop practice, or to collect their money for work done, and eventually there were over 33,000 contracts with perhaps 115,000 subcontracts, covering about 100,000 different articles. No one office could handle this volume of business, and the imperative necessity for decentralization was met by the creation of 13 Ordnance Districts, the country being divided on the basis of its ordnance manufacturing capacity. Each District Office became in time practically a branch of the office of the Chief of Ordnance, in respect to production and payments. There came to be handled in the thirteen district offices, contracts amounting to over $5,400,000,000. The contracts placed in the New York District amounted to $87,571 for each square mile of its area.

The Ordnance has now set up the same District organization to take care of ordnance procurement in event of another emergency. The new Districts are much the same as they were in the stormy days of four years ago.

The basis of this Division is industrial. Where the industrial activities of the country are concentrated, the Districts are small, where they are scattered the Districts are large. The Chiefs of the several Districts are men prominent in their communities, and patriotic enough to be willing to give their entire time to this work in event of war. Even in time of peace it makes large demands on their time. The question of procurement is a non-military one in its essentials, and the attainments and experience which qualify a man for District Chief very rarely exist in the Regular Army. Further, men in the Regular service with the capacity to develop into the caliber of District Chiefs would be needed elsewhere in time of war. Each District Chief must be a man well known in his community, and having the confidence of its organized industry. He must be a leading citizen, a big man for a big job. This very naturally brings us to the consideration of the Guest of Honor, Colonel John Ross Delafield, who was in the Coast Artillery of the National Guard of New York when the war came, was commissioned as a Major in the Ordnance Department, being mustered out nearly two years later as a Colonel. He was Financial Manager of the Chicago District, the third most important in the country. The signing of the Armistice changed the current of work in the Ordnance Department, the levers had to be reversed, and the brakes applied. Colonel Delafield had ideas and had been turning them over getting ready for the adjustment of contracts which he foresaw as a result of the cessation of hostilities. Putting them on paper which was forwarded to Washington brought him orders to follow the ideas to the Capital, where he became Assistant Chief of the Advisory Section of the Ordnance. Later his plans were adopted almost in entirety, and he became Chairman of the Board of Contract Adjustment. For his services in this latter capacity he was awarded the Distinguished Service Medal. We find him now still on the job, and this time as District Chief. He deserves your support and to succeed he must have it."

General Peirce discussed the industrial war plans of the Ordnance Department:

I am very glad of the opportunity which this occasion affords the Secretary of War and the Deputy Chief of Staff to see the type and caliber of men who worked with us during the war in the great adventure of marshalling the industrial resources of the country for the production of munitions, and upon whom we must depend for the same service in another like emergency. I say "the great adventure" because it was an excursion into a land of which we know but little beyond the borders and in which we had to make the roads as we advanced. The Assistant Secretary of War, in the execution of his function as head of War Department procurement activities, has come in contact with many of you before and therefore has a very keen appreciation of the value of your service and of your ability to render it.

The story of what you and your associates in the other districts of the country undertook and accomplished is an industrial epic. The horizon of your work was continually expanding. The size of the job increased by leaps and bounds. Starting with comparatively small appropriations in the late Spring of 1917, the appropriations and contract authorizations made by Congress for the use of the Ordnance Department totalled by the date of the Armistice the great sum of more

than $15,000,000,000. All existing facilities not required by our allies were put in action as fast as the organization could be expanded to handle the work. New facilities, ranging in size from simple extensions of existing plants to industrial cities, like the Old Hickory Powder Plant, Nitro, and Muscle Shoals, were built as rapidly as possible. Mistakes, delays, errors in judgment, were made of course, but these are part of the price that must be paid for action under such conditions. With almost nothing on hand the public nevertheless expected that men could be armed and equipped as fast as they could be mobilized. It was an impossible undertaking and will always be an impossible undertaking under the same conditions. But in spite of all handicaps, the result of your work was evident at the time of the armistice in the shape of the first ripples of an advancing wave of munitions that in the winter and spring of 1919 would have severely strained if not overwhelmed all available transportation.

The Industrial War Plans of the Ordnance Department are intended to make this work more definite and less difficult for those who will have to perform it in the next war and so avoid many of the delays in starting. Industrial War Plans seem a rather formidable title. While the working out of the details of these plans involves a really surprising amount of work, their aim can be quite simply stated. It is to have always on hand the answers to two questions, viz, "What do we have to get?" and "How are we going to get it?" The answer to the first is given by our book of requirements, in which the quantities of each item of ordnance supply and the rates at which these quantities must be furnished have been calculated and set down in accordance with the plans for the mobilization of men formulated by the General Staff. To carry out these plans completely there must be on hand as a reserve a sufficient quantity of each item to equip and maintain the men as they are mobilized until the date upon which new production can supply future needs.

The answer to the second question is our district office system, which, under the general direction of the Ordnance Office, is the operating force. At the time of our entrance into the World War, nobody knew the complete answer to either of these questions and both were handled in a more or less opportunist manner. The definite knowledge of what we have to do and how we are going to do it will permit us at least to start our journey promptly and move rapidly along a clear highway instead of groping through the thick underbrush of a forest.

One feature of our plans seems worthy of special attention. It is the chain of individual responsibility for performance which extends from the officer in charge of contract work at the manufacturing plant, up through the District Chief, the Chief of Manufacture in the Ordnance Office, the Chief of Ordnance, to the Assistant Secretary of War. The experience of the war, in my opinion, clearly demonstrated that such a line of individual responsibility, with commensurate authority, is necessary for the successful performance of a great work when time is a vital factor.

The Ordnance War Plans, however, are only a part of the larger plans of the War Department, some phases of which the Secretary of War has mentioned. The final objective of these plans is to provide an adequate defense of our country and its institutions, whenever threatened, at the minimum cost in lives and wealth. Surely that is an object which should appeal to every patriotic citizen. Once understood, there could be no difference of opinion as to that object. But the trouble is in getting the people generally to do the thinking needed for an understanding of this subject. Though your organization is primarily one for assistance in time of war, here is a direction in which you can be of the greatest assistance in time of peace. You can each in your own circle help to spread a proper understanding of the defense plans of the War Department, of their value and necessity, and so increase the popular support of these plans."

Colonel Delafield outlined the problem in the District:

I know *you all fully realize* the tremendous importance of the best and latest munitions in time of war, and *the absolute necessity for their rapid production* in a major emergency. So I will not add to what has already been said on these subjects, except to say that but for my absolute conviction that there is the greatest need of preparation for these things today, I would not have accepted the responsibility the Chief of Ordnance has placed upon me.

Picture to yourselves what would happen if we were suddenly thrown into a great war today. Most of you are Ordnance Reserve Officers. You would each want to start at once to help get the munitions, but, what organization would you join? What would be your work in it? What kind of munitions and what quantities must be made here? What manufacturers will make them? Today it would take much time and hard work to find the solution for all these questions and the delay might cripple and even cause the defeat of our armies. Such a condition must not be allowed to continue. It is up to us Ordnance Officers to overcome it and we can do it. If we do not we are not worthy of our commissions.

I do want to say *a few words about the New York Ordnance District*, and the great and important work it has before it. I will go directly into a statement of *what we have to do* to organize and do the work of the New York Ordnance District.

Our problem in this District is to so arrange everything that in case of a major emergency we can immediately put into operation contracts for production with more than a thousand different contractors. And also have in readiness the trained personnel amounting to not less than 600 officers and civilians required to care for this immense volume of business. We may even have to create a larger organization and have a greater number of contracts. During the last war there were about 3,500 contracts with some 2,000 contractors in this District. But it is thought that by a thorough system of preparation in advance we can materially cut this down. We will probably have to begin our work by—

1. An *initial survey* of the facilities in our District and report on these.

The Ordnance Department will furnish us lists of its requirements. These lists will give brief descriptions of the articles required and will state the quantities of each. There are more than 125,000 of such articles, including the component parts.

We must then investigate and determine which of them and what quantities of each can be produced by the manufacturers in our District.

These facts we must tabulate and report back to the Chief of Ordnance.

2. *Allocation of Orders.* The Ordnance Department will then allocate to our District the particular articles and the quantities of each to be manufactured in our District in an emergency.

We will then have to *allocate to the various manufacturers* in our District the articles and quantities each is to manufacture.

If possible some kind of *an arrangement must be negotiated with each manufacturer* so as to insure prompt production when directed to go ahead.

During the last war over 3,500 contracts, amounting to over $750,000,000, were made between the Ordnance Department and some 2,000 contractors in this District. The contract burden per square mile of territory was the largest of any of the Districts, amounting to $84,571.

3. *Information to Manufacturers.* The Ordnance Department will furnish to the District, details, plans, specifications, etc., for the articles to be manufactured in the District and for the machinery required to do the work.

These will be placed with the manufacturers and it will be for us to *instruct the manufacturers' personnel* in their meaning and use.

4. So far as possible *aid should be given to the manufacturers* by arranging to help them get the raw materials that may be required and also for their financing. For immediately upon the outbreak of war it is often hard to arrange for the required funds.

5. *Inspection and Reallocation.* After these first arrangements are completed it will be necessary to follow up with each manufacturer to watch his capacity to produce, which may increase or diminish.

The *allocations will be shifted* in character and amount among the manufacturers, or to new ones, as their capacity or plant changes, or as new facilities are found in our District.

One of the functions of the District Organization will also be to maintain a frequent *survey for possible new sources* of manufacture and to report these to the Ordnance Department.

6. There must be maintained also a systematic *instruction of our own District Officers* to keep them abreast of all Ordnance improvements and methods.

7. *Office Records.*

There must be maintained at the District Office—

(*a*) A complete *list of all available manufacturers* in the District arranged in classifications under various headings, as for example:

Alphabetical,
Locality,
According to articles to be manufactured.

(*b*) A complete *list of the personnel of the District* arranged in the following classifications:

Alphabetical,
Locality,
By divisions and sections to which assigned,
By grade in the Army,
By education and training.

A similar list of available personnel:

Alphabetical,
Locality,
By grade in the Army,
By education and training.

(*c*) Loose leaf *alphabetical books in which each contract* shall be entered with its principal details in readiness for production entires of deliveries and of payments.

8. *The personnel we must have for this:*

(*a*) *Form of Organization.*

The Ordnance Department has prescribed an organization for each District. This prescribes six divisions, each with its Chief, namely—

Administration,
Artillery,
Ammunition,
Aircraft Armament,
Tank, Tractor and Trailer and
Small Arms.

Each of these divisions sub-divides into sections, each with its Chief, so for example the Ammunition Division has three sections—

Explosives,
Metal Components,
Loading.

Under the Chiefs of the Sections will be grouped the main body of the personnel.

(*b*) This organization is what is called *vertical as distinguished from* the form of organization in the last war, which was called *horizontal*. Then the plan was to group all inspection, whether of bagging, guns, explosives, or optical instruments, etc., under one head, so also with production and other functions. But the present or vertical plan is to sub-divide according to the materials to be made and to have the inspection, production, etc., carried on within the group familiar with and in charge of each class of material.

This organization contemplates that the procurement, production, inspection, etc., shall be conducted practically entirely in the District by the District Officers.

Moreover, the Chief of each division will be responsible for the production, inspection, etc., in his division, and the Chief of each section under him for the production and inspection under every contract in his section.

(*c*) *The number of officers required.* A large number of officers will be required in this work in time of war when not less than 2,500 contracts in more than 1,000 different plants will be in operation at one time.

There will not be several officers concerned with the work at each plant as there were in the last war. There will be but one Ordnance Officer for each group of plants, and he will have the considerable responsibility for production, inspection, etc. He must, therefore, be a man of some ability.

This will make a total of say about 600 officers and civilians required for this District in time of war, of whom say about half should be officers.

In time of peace preparation practically the *same number of officers* are *required* because:

(1) There should be a man ready to take each important position immediately in case of war.

(2) Each officer in peace time can give only a small part of his time to this work, so that it must be shared by many to reduce the burden upon each one.

(*d*) *Summary of Officers' Work.* The books and records at the District Office will be kept in time of peace mostly by the Executive Officer and the employed personnel there, though the Reserve Officers should be familiar with this also, as they will have to supervise this work in time of war.

But the work with the contractors must be done almost entirely by the Reserve Officers both in peace and war time.

This involves—

(1) The initial survey which cannot be thoroughly accomplished without the co-operation of a number of officers.

(2) The placing or allocation of orders with the contractors.

(3) The instruction of the contractors' personnel, by explaining drawings, specifications, machinery, methods, etc.

(4) The keeping in touch with the contractors and their plants and reporting conditions at each plant.

(5) The constant search for new or additional opportunities for manufacture of Ordnance material.

Doubtless you have each asked yourselves—*What am I going to do* if another great war comes on? Is it going to be a matter mostly of chance where I will be assigned? I am a Reserve Officer, but how am I going to help? Gentlemen, the work of the Ordnance District is the answer for many of you. It is in this unit of the United States Army you will do the most effective work for your country's defense.

I am asked to serve with you as District Chief for this work, and as such will have to give much more of my time and make greater sacrifices than any of you. I am ready and willing to give the best there is in me to accomplish this work, but I can do nothing without your co-operation and your active help.

We are the most important Ordnance District of the twelve in the United States. We should take the lead in the effectiveness of our preparation. Without your active help nothing can be done, with it we can build and maintain the best Ordnance District, the best prepared for war in the country.

I am here tonight to appear for your active help and support of the Ordnance District and I believe you will give it.

That the purposes and efforts of the Army Ordnance Association are bearing fruit throughout the country is evidenced by an editorial which appeared in the New York *Sun* of October 25, 1922, under the title "Preparedness of Mind."

The warning uttered by the Secretary of War in his address at the Army and Navy Club deserves attention from every one who wants to see the country secure from easily avoidable mistakes in any future war emergency. To different people military preparedness has come to mean very different things. Some call for an army of a certain number; others for stores of equipment; others put the stress on intensive training for the business of defense; yet others want the producers of war munitions to keep the means of great production in readiness.

In the meanwhile, as Secretary Weeks says, other people may drift back into the "shortsighted, happy-go-lucky" frame of mind, the very spirit of unpreparedness. Whatever guise or degree of precaution for the distant future may meet the approval of the cautious citizen, he must agree with the Secretary on the need not to be caught again as the war found us.

In 1917 other nations held the enemy in check. They kept his fleet, save for ravaging submarines, out of our waters, and prevented an attack upon American territory. We should not have fared so well in a conflict that would have thrown us into the first line of combat. Neither should we then have had the results of two vigorous allies' years of experience and error and improvement to guide us from the start. America came in under the most favorable conditions. It could not hope to make even so good a showing for all its expenditure of treasure and energy again, unless it would profit by experience.

Preparedness concerns not only weapons and technical drill, it concerns the public state of mind. Bryan's fancied instant levy of millions of defenders "before sundown" was not so far astray from the belief of great numbers of us. Such an idea as he expressed sums up the whole of mental and moral unpreparedness. Yet he uttered it only a little more than half a century after the close of a great struggle that had torn the country unforgetably. Fifty years is not a long time. Children now living would suffer needlessly if in a war breaking out fifty years from the day of the Armistice, great follies should follow upon our forgetfulness of the last war's lessons.

One of the first lessons is that war costs money, that it eats to the very heart of a nation's credit, if it can, and that the nation of strong credit will win, other things being equal. That truth should inspire the American to urge and seek the repayment of America's domestic debt, as a matter of building the credit defenses up again.

Further, the war taught us that the industrial development of a nation helps it in war; that its peaceful factories become its means of piling up the vast system of munitions that makes warfare increasingly the monopoly of the industrial Powers. From this one may conclude that strong, sustained growth of American industries works to make the country safer in any sustained contest with an outside enemy. Industry gains thus a new value and meaning for us.

Above all, the value of education in the needs and situations of a state of war has been taught us. It would be a terrible waste of dear experience if the children of the future should not have a clear knowledge of what we learned to be necessary, and what unavoidable in 1917 and 1918.

(Continued from Page 163)

HOW. {GERMAN OR U.S. MODEL}	GER. 98/09	U.S. 1917	U.S. 1908MI	GER 1896	GER 1902	U.S. 1908MI	GER 1913	U.S. 1917	GER 1913	GER. 1911	GER. 1911	GER.	U.S. 1917
CALIBER	105 M/M	3.8 IN.	4.7 IN.	150 M/M	150 M/M	6. IN	150 M/M	155 M/M	150 M/M	210 M/M	305 M/M	420 M/M	8. IN.
WEIGHT OF HOW. (LBS.)		681	1056	2366		1925	1736	2745	1820	4405			6552
MUZZLE VELOCITY (FT./SEC.)	991	1200	900	905	1197	900	1196	1420	1235	820		1100	1300
MUZZLE ENERGY (FT./TON.)	194	300	675	525		675		1319.4		1440		11475	2345
MAX. ELEVATION (DEG.)	40	48	40		40	40	40	42.33	45	65		60	50
MAX. DEPRESSION (DEG.)	-13	-5	-5			-5		0		-5			0
TOTAL TRAVERSE (DEG.)	4	45	6		4	6	4	6	4	6			8
LENGTH OF RECOIL (INCH.)	51	45 / 25	52 / 24					51.3		35.5 / 25.6		48	60 / 24
LENGTH OF HOW. (CAL.)	12	13.5	13.6	10.8	11	13.6	14	15	17	15	14	8.4	14.7
RANGE (YDS.)	7655	8500	6640	6616	8088	6704	9296	13000	9296	7060	12775	10274	10760
BREECH MECHANISM (TYPE)	WEDGE	BLOCK	SCREW	WEDGE	WEDGE	SCREW	WEDGE	SCREW	WEDGE	WEDGE	WEDGE	WEDGE	SCREW
HEIGHT OF BORE (INCH.)		41	38			54.5		56.4		64.8			60
RECUPERATION {HYDRO.-SPRING / HYDRO.-PNEU.}	HYD-SPR.	HYD-SPR.	HYD-SPR.		HYD-SPR.	HYD-SPR.	HYD-SPR.	HYD-PNEU.	HYD-SPR.		RACK	HYD-PNEU.	HYD-PNEU.
TRAVERSE {AXLE / PINTLE}	PINTLE	PINTLE	PINTLE		PINTLE	PINTLE	PINTLE	AXLE	PINTLE	PINTLE		WEDGE	PINTLE
WEIGHT OF {SHELL OR SHRAPNEL}	28.2 / 34.8	30	60	90.3	90.3	120	90.3	95	903	308	735	1365	200
LINE OF SIGHT {DEPENDENT / INDEPENDENT}	DEP.	IND.	DEP.		DEP.	DEP.	DEP.		DEP.				DEP.
KIND OF SIGHT {PANORAMIC / GONIOMETERIC / TELESCOPIC}	PAN.	PAN.	PAN.	PAN.	PAN.	PAN.	PAN	PAN.	PAN.	PAN.			PAN.
DIA. OF WHEEL (INCH.)	48	58	58			60		53					66
WIDTH OF TRACK (INCH.)	60	60	60			60		60					76
WEIGHT OF HOW. & CARR. FIRING POSITION (LBS.)	2690	2981	3988		4628	7582	4705	7600	4816	14650	35800	213780	19100
WEIGHT OF CAISSON & LIMBER (LBS.)		4570	4726		6546	8251		7898	6546				
NO. OF LOADS HOW. & CARRIAGE	1	1	1	1	1	1	1	1		3		5	1

General Characteristics, U. S. and German Artillery at Entrance of the U. S. in the War—Howitzer

CHARACTERISTICS	HOWITZERS						GUNS				
CANNON {GERMAN OR U.S. MODEL}	GER. 1916	GER. KRUPP	GER. 1917	U.S. 1918	GER. 1916	U.S. 1918	GER. 1916	U.S. 1916	GER. 1916	GER. 1916	U.S. FILLOUX
CALIBER	105 M/M	105 M/M	150 M/M	155 M/M	305 M/M	240 M/M	77 M/M	75 M/M	105 M/M	150 M/M	155 M/M
WEIGHT OF CANNON (LBS.)				2745		10790	833	765			8795
MUZZLE VELOCITY (FT./SEC.)	1402	1480		1420		1700	1968	1750		1640	2380
MUZZLE ENERGY (FT./TON.)	482			1319.4		7115.6	406	258.5		2240	3550.6
MAX. ELEVATION (DEG.)	40		45	42.33		60	40	53	45	42	35
MAX. DEPRESSION (DEG.)	-10			0		-9.25	-10	-7	0	0	0
TOTAL TRAVERSE (DEG.)	4		4	6		20	4	45	7°-52′	7	60
LENGTH OF RECOIL (INCH.)				51.3		44.83	47.2 / 43.3	46 / 18			71 / 43
LENGTH OF CANNON (CAL.)	22	20	15.1	15		19.75	35	28.4	37.7	43	38
RANGE (YDS.)	10930	11700		13000		18000	11264	9700	21600	24900	17717
BREECH MECHANISM (TYPE)	WEDGE	WEDGE	WEDGE	SCREW		SCREW	WEDGE	BLOCK	WEDGE	WEDGE	SCREW
HEIGHT OF BORE (INCH.)				56.4			41.7	41.6			58.35
RECUPERATION {HYDRO.-SPRING / HYDRO.-PNEU.}	HYD-SPR.		HYD-PNEU.	HYD-PNEU.		HYD-PNEU.	HYD-SPR.	HYD-SPR.	HYD-PNEU.		HYD-PNEU.
TRAVERSE {AXLE / PINTLE}	PINTLE		PINTLE	AXLE		PINTLE		RACK	PINTLE	PINTLE	RACK
WEIGHT OF {SHELL OR SHRAPNEL}	35.3	34.5	90.3	95		356	16		39.6	112	95
LINE OF SIGHT {DEPENDENT / INDEPENDENT}	DEP.					IND.	IND.	IND.		IND.	DEP.
KIND OF SIGHT {PANORAMIC / GONIOMETERIC / TELESCOPIC}	PAN.			PAN		PAN.	PAN.	PAN.	PAN.	PAN.	PAN.
DIA. OF WHEEL (INCH.)				53		60		56			45.5
WIDTH OF TRACK (INCH.)				60		63.84		60			88.5
WEIGHT OF CANNON & CARR. FIRING POSITION (LBS.)	3085			7600		41296	3085	3045	7160	22040	25960
WEIGHT OF CAISSON & LIMBER (LBS.)	4000			7898			4094	4570	6000		
NO. OF LOADS CANNON & CARRIAGE	1			1		1	1	1	2		1

General Characteristics, U. S. and German Artillery Developed during the War

Artillery Division Notes

Flexible Suspension and Track for Track-Laying Vehicles.—The conventional type of track and suspension as used on track-laying vehicles is subject to certain limitations. The first object of a track-laying vehicle is to effect a distribution of the weight of the vehicle so as to reduce the bearing pressure per unit of area, permitting operation over soft ground or off roads. For certain types of commercial vehicles and for war service vehicles, low bearing pressure is necessary. The additional construction necessary, such as truck frames, truck rollers and equalizing mechanisms, adds weight as well as additional parts to maintain. As the track type of vehicle is desirable for war service vehicles on account of low ground pressure, improvements in design to remove limitations affecting its operation are necessary if the development of the type is to continue and satisfactory vehicles are to be produced.

The operation of vehicles equipped with tracks puts stresses into the running gear and frame not found in the wheeled vehicle. When turning, for example, the ordinary track is subject to heavy side strains and the track parts must be strong enough to resist the side strain. This condition requires somewhat heavier construction than would be the case if provision could be made for relieving the side load on the track.

The trucks and running gear must also be made sufficiently rigid to care for the side strains. In some types of construction the truck rollers are rigidly mounted in the frame of the vehicle providing no means for relieving side loads on the track or on the frame. Many large tanks have this type of construction but such vehicles, while large, operate at very low speeds.

For heavy vehicles to operate at higher speeds the running gear must be spring suspended and trucks equalized to reduce shock to the vehicle, to permit the track to follow the contour of the ground and to make the vehicle ride with some degree of comfort to the operators. With this type of construction no provision is made to take care of the side strains that come on the track and running gear when turning. Turning with the rigid type of track also demands the maximum power and under certain ground conditions, the power required is in excess of that available in the power plant.

To overcome some of these difficulties, the Ordnance Department is now considering for war service vehicles, the use of a chain or cable suspension used in conjunction with swinging bogies. In this type of suspension, which originated in England and is being studied for commercial adaptation in this country, the weight of the vehicle is distributed uniformly over all of the truck wheels. Each bogie carrying two truck wheels not only has a vertical motion, but a lateral swinging motion as well, so that the track can conform to the contour of the ground, and the bogie can swing thus relieving side strains.

Due to the ability of the track bogie to carry its load whether above or below its normal position, there is no concentration of the weight of the machine on one or two bogies as is possible in vehicles using individually sprung bogies or truck frames with a limited spring absorption. This means that the track suspension parts can be designed to take a uniform load at all times without having to provide capacity for carrying the entire weight of one side of the vehicle on one bogie.

Due to the lateral flexibility of the track and track bogies, it is possible to lay the track in a curve when turning the vehicle, over which curved track the track bogies can follow. As long as the minimum radius of turning can be accommodated by the side movement of the bogie in its frame no skidding of the track on the ground will occur. As there are no side strains set up in steering no great strength must be provided as in the case where the track must be skidded sideways on the ground in steering.

Figure I shows in elevation and section one bogie and the method of suspension.

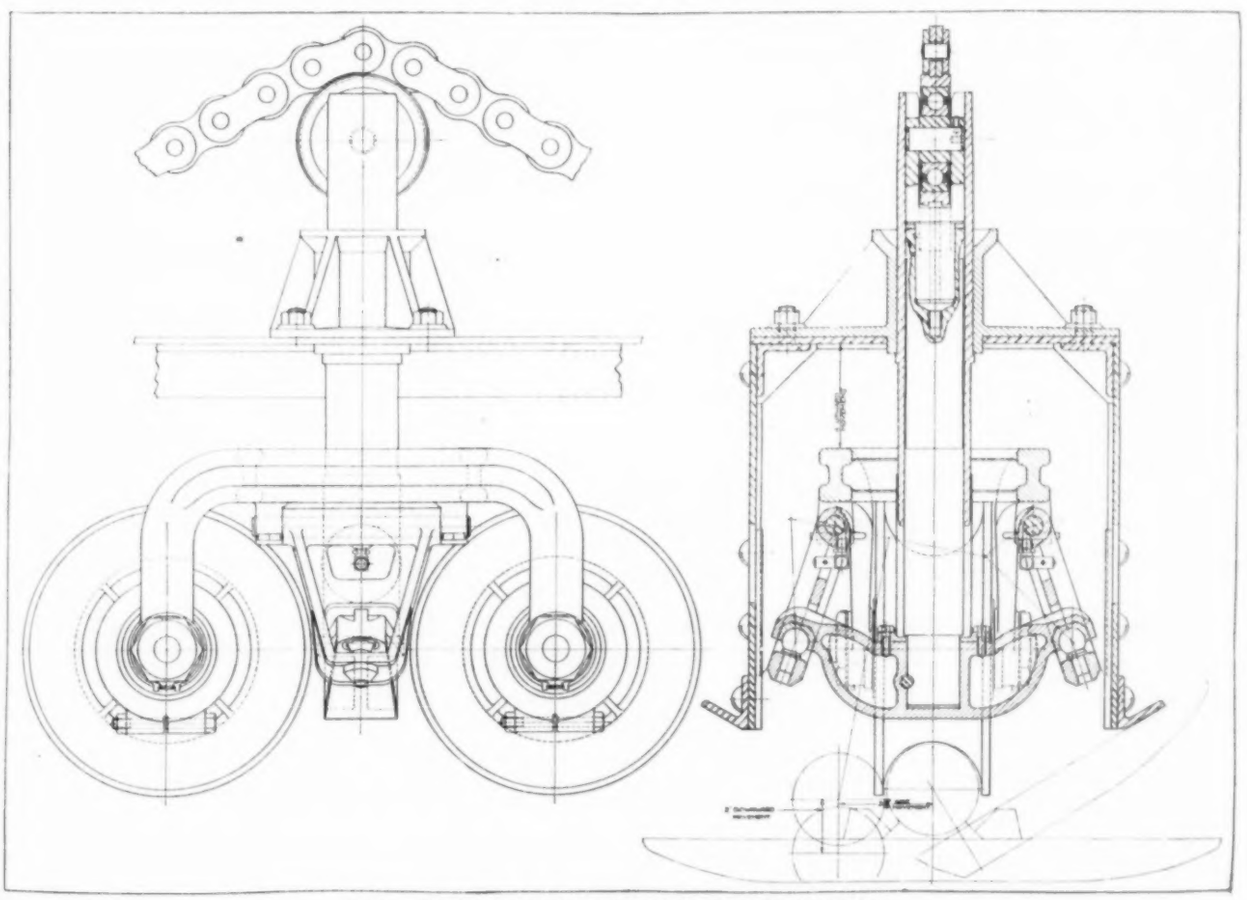


Fig. 1 Flexible Suspension and Track for Track-Laying Vehicles

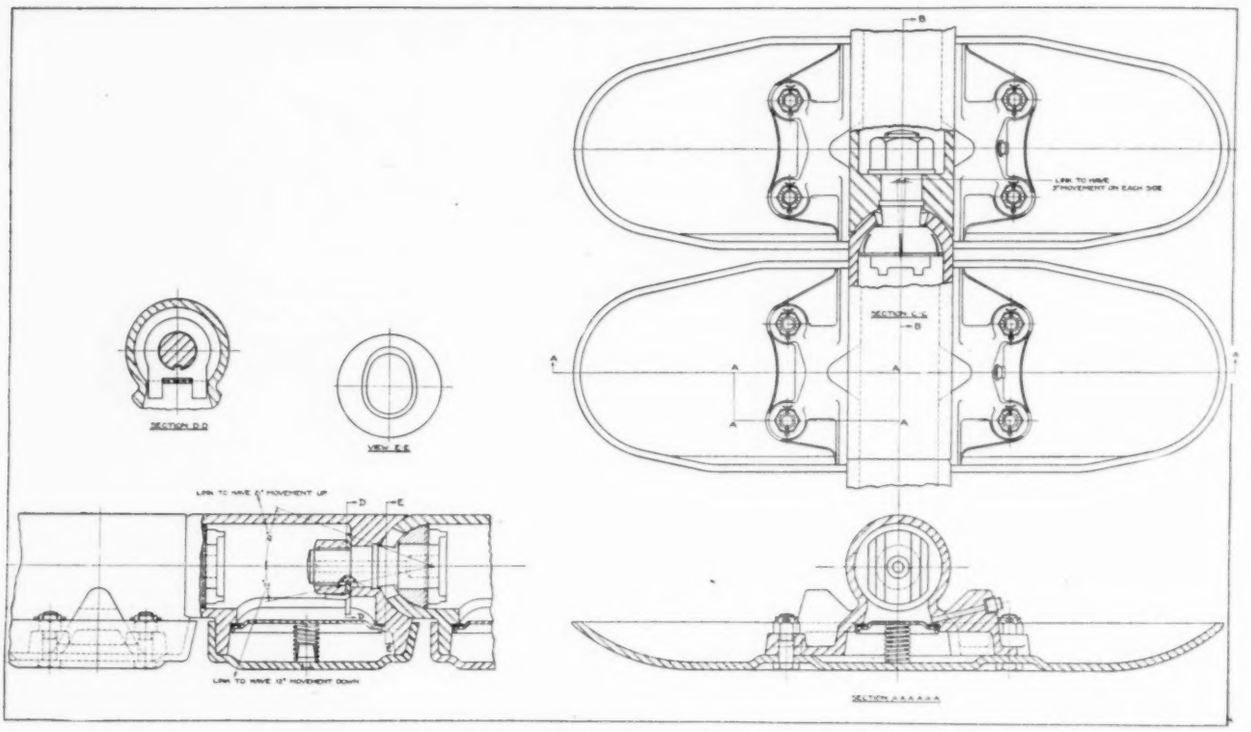


Fig. 2 Flexible Suspension and Track for Track-Laying Vehicles

Figure 2 shows the track construction. The ball and socket construction allows each link to assume a position on the ground independent of any other link, a degree of flexibility not possible with the usual type of hinge joint.

Lubrication of truck pins in the regular type of construction is a very difficult problem. With the track illustrated, the center of each link is an oil pocket, and all the oil pockets are open to each other throughout the length of track. As the joint itself is a close fitting ball and socket, the oil is retained for a considerable time, thus insuring satisfactory lubrication for the joints.

Track and Track Suspension for 1600-*lb. Reconnaissance Tractor.*—The track mechanism and suspension used on the 1600-lb. reconnaissance tractor are shown diagrammatically in Figure 1. The track mechanism consists of two track frames, each having four wheels with pneumatic tires, four cantilever leaf springs, two semi-elliptic leaf springs and a Chase type of track passing around the wheels. The track frames are built up members, consisting of two frames spaced about six inches apart and held together by transoms. The wheels are mounted between these frames.

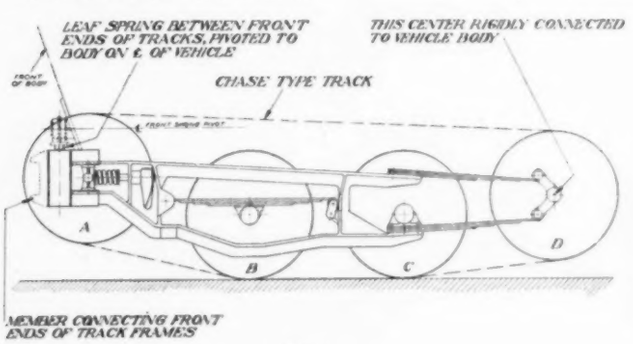
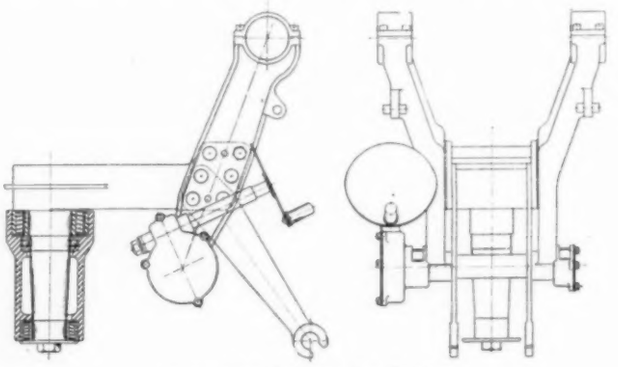

LEAF SPRING BETWEEN FRONT ENDS OF TRACKS, PIVOTED TO BODY ON ℄ OF VEHICLE
THIS CENTER RIGIDLY CONNECTED TO VEHICLE BODY
CHASE TYPE TRACK
A
B
C
D
MEMBER CONNECTING FRONT ENDS OF TRACK FRAMES

Fig. 1

The track frames are connected at their front ends by a pressed steel member and this member is connected to the vehicle through a leaf spring, running parallel to it, and pivoted to the vehicle body on the center line of the vehicle. The rear ends of the track frames are connected to the rear axle through leaf springs. The rear axle is rigidly connected to the vehicle body and is so located that the rear wheels "D" are normally off the ground.

The front wheels "A" are so mounted in the track frames that they can move forward or backward. Springs are provided between the members carrying the wheels and the track frames to provide track tension and to allow rearward movement of the wheels when foreign matter lodges between the wheels and the track. These wheels "A" are so located that they are normally off the ground and the two center wheels "B" and "C" carry the load. The wheel "B" is spring mounted in the track frame and the wheel "C" is spring mounted in the sense that the entire track frame is so mounted. The individual spring mounting of the wheel "B" in addition to the spring mounting of the entire track mechanism is intended to lessen the shocks caused by passing over uneven surfaces.

75-mm. Gun Carriage, Model 1923 E, Top Carriage.—A full size model of the 75-mm. Gun Carriage, Model 1923 E, has been constructed at the Rock Island Arsenal. The gun and recoil mechanism of this carriage are much lighter than similar parts of the 75-mm. Gun Carriage, Model 1920. Both



75-mm. Gun Carriage: Top Carriage

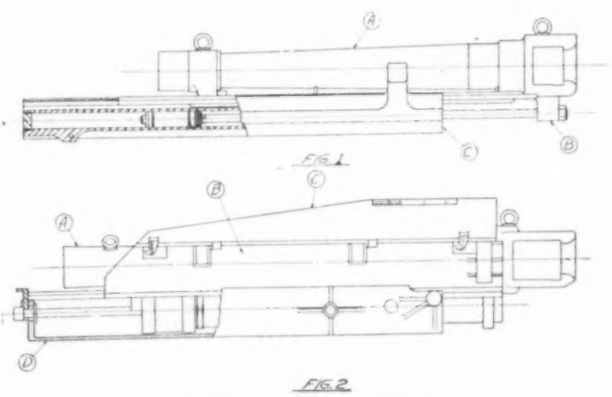
carriages are of the split trail type. As the tipping parts and wheels are lighter than the Model 1920 carriage, it was necessary to lengthen the trails to get sufficient stability. The cradle trunnions are at the rear of the cradle and are 19 inches in rear of the axle. The pintle of the top carriage rotates about the center of the axle. The top carriage is of unusual construction, consisting of a steel casting supporting the trunnions at its upper end and the angle of site shaft and gearing

at its lower end. Near the middle there is a steel forging riveted to it which has a projection that fits into a suitable pocket in the axle. The rear end of the forging is forked to permit the equilibrator, for balancing the tipping parts, to pass through.

Anti-friction bearings are provided. Those in the trunnions are Hyatt Roller bearings. These have given satisfaction as trunnion bearings when tried on one of the 75-mm. gun carriages, model 1920. The angle of site shaft is also supported on roller bearings. Similar bearings were used on the redesigned angle of site mechanism of the 105-mm. howitzer carriage, Model 1921 E, and are reported to have stood up under the firing load. The pintle is supported in the axle by a ball bearing to take the vertical load and by two roller bearings to take the horizontal and rotating forces. This construction has never been used on a field carriage but the mounting has been considered satisfactory by the bearing manufacturer and a similar construction is in use on one of the motor carriages. The use of anti-friction bearings should facilitate the operation of laying the gun.

A rear traveling lock by means of which any lost motion between the axle and top carriage can be taken up is provided. There is one of these on each side of the top carriage and lock to the trail. They are adjustable, easily operated and should reduce vibration and wear when traveling.

Recoiling Parts in Pack Howitzer Carriages.—In the arrangement of recoiling parts in the 75-mm. Pack Howitzer Carriage, Model 1920, Fig. 1, the Gun A is secured to the Sleigh B to which is also attached the Piston Rod at the



Recoiling Parts in Pack Howitzer

rear end. These three members, Gun, Sleigh and Piston Rod, move in recoil on the Cradle C which is the stationary member containing the recoil mechanism.

This practice of using the recoil mechanism member as a slide for the gun is generally followed in field carriage design, and in this carriage the Sleigh was introduced to facilitate removal of the Gun quickly without removing the slide rails from the Cradle guides.

Of the total weight of these parts, 54 per cent were recoiling and 46 per cent were stationary.

In the Model 1923 Carriage, Fig. 2, the Gun A is seated in a U-shaped Bottom Sleigh B which contains the recoil mechanism. For pack purposes the Gun is separated into two sections, tube and breech, the breech section engaging the Bottom Sleigh by means of side lugs. A Top Sleigh C is secured to the Bottom Sleigh which serves to hold the Gun in place and prevent rotation about its axis. The Top Sleigh further serves as a counter-weight to bring the center of gravity of the recoiling parts near the center line of the bore, an important detail affecting stability of the carriage and strength of certain parts. The Bottom Sleigh has slide rails for engaging the guides in the Cradle D which is the stationary member to which is attached the Piston Rod at the front end.

It will be seen therefore that all these parts, including the recoil mechanism, move in recoil except the Cradle and Piston Rod.

Of the total weight of these parts, 80 per cent are recoiling and 20 per cent are stationary.

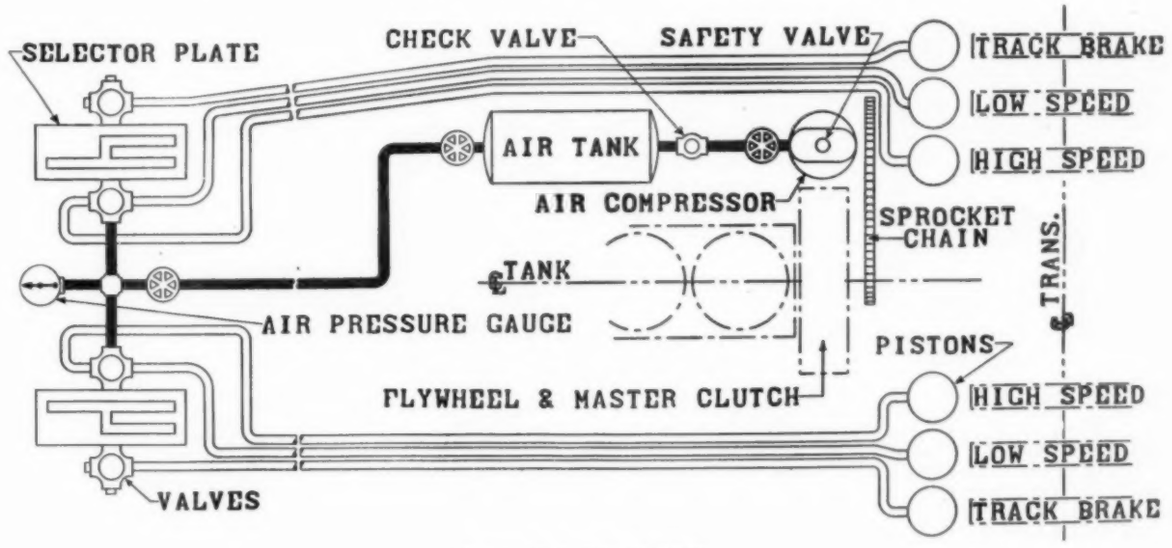
In comparison with the Model 1920 Carriage this arrangement results in a reduction in piston rod pull of approximately 36 per cent with a corresponding increase in stability of the carriage.

Pneumatic Control for Tanks.—The control of heavy tanks equipped with epicyclic transmissions is one of the problems now being given serious consideration by the Ordnance Department in the design of experimental tanks. The present manually operated controls are not satisfactory, due to the great physical exertion required of the driver to maneuver these heavy vehicles.

The heavy driving torque developed by the power plant in a large tank requires unusual care in the layout of the leverage systems for the manually operated controls, especially in view of the fact that the transmission is located at the rear of the tank while the operator must be placed at the extreme front end. This leverage and control apparatus becomes a complicated system, the location of which must be definitely planned. The physical effort which the tank driver can exert is rather definitely fixed, and this effort must overcome the friction losses throughout the leverage system as well as being utilized to apply the brakes controlling the speeds of the epicyclic transmission and also the track brakes.

The tank driver, in addition to the control difficulties of maneuvering a heavy vehicle, is able to see but very little of the ground around the tank. His vision is impaired by the armor plate, in which small eye slits are cut, providing the only means by which he is able to see the terrain over which he is guiding the tank.

With the idea of simplifying the control system and making its operation satisfactory without great physical exertion on



Pneumatic Control for Tanks

the part of the operator, the Ordnance Department has developed and installed in one of 20-ton Medium tanks, Model 1921, an experimental pneumatic control system. This control system is shown diagrammatically in the accompanying illustration.

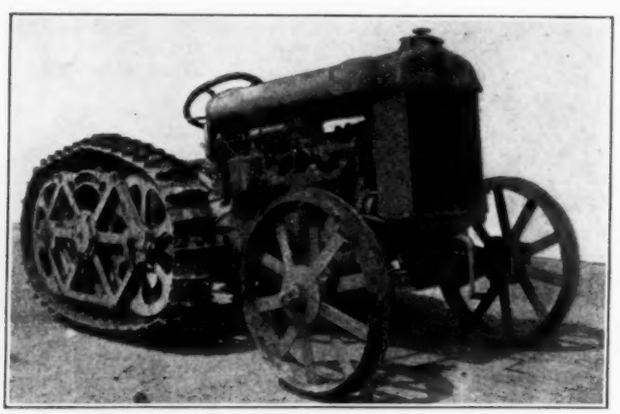
It will be seen from the diagram that this system includes an air compressor having two 2½" × 3" cylinders directly connected to the engine and which is always running when the clutch is engaged. The compressor is driven at half engine speed by a roller chain drive. The compressor has an adjustable safety valve set for a pressure from 100 to 125 lbs. A 1½ cu. ft. capacity air tank serves as a reservoir in which to store the compressed air. Between the tank and compressor a check valve is installed to prevent a back flow of air. An air gauge mounted in front of the driver shows the pressure available at all times. The pipes shown in black indicate pipes containing air under pressure at all times. The movement f the control levers in the selector plates controls the flow of air to the cylinders at the brake bands.

In the transmission in this tank power is transmitted from the power plant through a two speed and reverse bevel gear set to a two speed epicyclic transmission. The combination of bevel gear set and epicyclic provides four forward speeds and two reverse speeds. The different epicyclic reductions are brought into action by applying contracting brake bands on drums on the transmission. In addition to the brakes on the epicyclic transmission two track brakes are provided and are controlled independently. All brakes are operated by air cylinders located at the transmission.

The control system is equipped with small easily operated valves located at the driver's seat. The connection between the driver's seat and the transmission consists of pipes which can be placed to suit the space available in the tank.

In the experimental installation, the pneumatic control has been applied only to the epicyclic brakes and track brakes. Pneumatic control may later also be applied to gear shifting, thus giving complete control with the minimum of effort on the part of the operator.

Test of Fordson Tractor with Hadfield-Penfield Adapter.— As an initial step in determining the value of commercial tractors for use with Divisional Artillery, there have been procured and tested at the Aberdeen Proving Ground, two Fordson tractors, one of which was equipped with a Bates adapter



Fordson Tractor with Hadfield-Penfield Adapter

and the other with an adapter made by the Hadfield-Penfield Steel Company. The tractor equipped with the Hadfield-Penfield adapter stood up better in test, and the details of test as given below will be confined entirely to this last mentioned equipment.

The object of the test was to determine the limits within which this equipment would be suitable for use with the Divisional Artillery, and particularly to determine whether or not the tractor with adapter could be run for a period of thirty days with only such minor repairs and adjustments as could be readily made by a maintenance company in the field.

The tractor proper is of the commercial Fordson type, in which the rear wheels were replaced by track-laying adapters. The adapter is also a commercial product manufactured by the Hadfield-Penfield Steel Company, Bucyrus, Ohio, primarily intended for increasing the draw bar pull of the standard Fordson tractor for farm use and, on account of the lower ground pressure under the adapter, to facilitate its operation on soft ground. The adapter is made mainly of manganese steel, and consists of sprockets assembled to the Fordson axle with track frames extending to the front and rear of the driving sprocket for the purpose of carrying the front and rear idlers. The track proper is of the so-called "rigid" type, in that the relative movement of adjacent shoes is so restricted that the track can only flatten out sufficiently to conform closely to the contour made by the driving sprockets and idlers. The adapter unit on each side of the vehicle is pivoted on the axle housing and is allowed only a limited movement sufficient to care for the usual variations in ground contour. There is no inter-connection between the adapter elements on each side of the vehicle. The tendency of the tractor to upset backwards is remedied by stops on the rear axle housing, which come into action when the tractor is pivoted about the adapter through a positively defined angle. Furthermore, the tendency to tip backwards is lessened by the fact that the overturning must take place about the extreme rear end of the adapter. The braking of the vehicle is accomplished through independently controlled hand brakes of the external band type acting on the driving sprockets.

The following dimensions and specifications for the Hadfield-Penfield adapter are noted below:

Length overall	72½"
Width overall	55½"
Height overall	39"
Length of track	160⅞"
Number of track links	39
Width of track link	9"
Length of track bearing on hard ground	4"
Length of track bearing on ground after 3" penetration	47"
Area of track bearing on ground after 5" penetration	845 sq. in.
Unit ground pressure after 5" penetration (normal division of weight between front wheels and tracks)	3.58 lbs. sq. in.
Unit ground pressure after 5" penetration (with weight normally on front wheels transferred to track by pull exerted)	4.87 lbs. sq. in.
Pitch diameter of sprocket	31.81
Number of teeth in sprocket	24
Pitch of track	4"
Diameter of sprocket and track (to tips of cleats)	40⅛"
Gear ratio—expressed in number of engine revolutions per foot of travel on hard roads. Low gear	9.25
Gear ratio—expressed in number of engine revolutions per foot of travel on hard roads. Intermediate gear	5.01
Gear ratio—expressed in number of engine revolutions on hard roads. High gear	2.00
Distance tractor advances on concrete surface per revolutions of drive sprocket (no load)	8.77
Ground clearance under center of tractor	9⅜"
Ground clearance under middle rear axle housing	8"
Ground clearance minimum	8"
Total weight including Fordson	4120 lbs.
Total weight of adapters	1370 lbs.
Weight on front wheels of Fordson	1100 lbs.
Weight on tracks	3020 lbs.
Weight on left side	2060 lbs.
Weight on right side	2060 lbs.

Before equipping the Fordson tractor with the adapter, it was given a preliminary run of fifty miles over a standard test course at the Proving Ground, during which run the tractor performed satisfactorily. After a preliminary run of 12 miles on July 25, 1922, which was made for the purpose of ascertaining if the adapters were satisfactorily adjusted, the regular road test was inaugurated and was extended to September 6, 1922. During this period of 44 calendar days, the vehicle was road tested 31 days, was in the shop for repairs a portion of two days, and for the remaining 11 days it did not leave the shop but for reasons not connected with the failure of the vehicle. The road test for the period stated was made in all kinds of weather and over varied condition of roads. After the 30 days of running pulling the 75-mm. Gun, Model 1916, and Limber, weight of 4,569 lbs., a distance of 544 miles, at an average sustained speed of 5 miles an hour, the adapters were still serviceable and no difficulty of any consequence was had with the Fordson tractor proper.

It was noted in the test that the tractor handled easily

in turning, the movement being assisted by the individual brakes, hand operated on each of the adapters. In heavy mud the traction was not sufficient and turning was extremely difficult when the double load of gun and limber was towed. On concrete roads, however, or upon good dirt roads, the tractor had no difficulty in hauling the gun and limber and turning was accomplished without difficulty.

Due to the design of track as previously described, when operating over ordinary terrain on a fairly good road surface, the portion of the track coming in contact with the ground is, in effect, a rigid rail approximately 36 inches long, and the power losses in the track due to compressing the earth between the cleats as the rails gain contact with the ground are reduced to a minimum.

It was found during test that the tendency to overturn backwards was positively overcome with the adapter used. This was due to the stops which are attached to the rear axle housing coming into action, after which tipping must be accomplished at the extreme rear end of the adapter as a pivot, which is usually impossible. Due, however, to the failure of one of the stops during road test, one of the adapters turned completely over when the track became locked.

One conclusion which may be derived from the test is to the effect that the low ground clearance of the tractor is inherent in the design, and this cannot be overcome as the clearance is determined by the diameter of the driving sprocket which in turn is limited by the necessity of gearing down the tractor to a point where it will develop a draw bar pull equal to the available traction. In addition to reducing the ground clearance of the tractor, the motor is tilted toward the rear which tends to prevent proper lubrication of the front bearings of the motor by the splash system used.

In reference to the inadequate ground clearance, it may be noted that in the military service tractors would operate independently on very rare occasions, so that if, when operating in batteries of four or more, a tractor should become mired due to the small ground clearance, it would be feasible to use one or more of the other tractors of the battery to extricate the mired tractor.

It will be noted from the description of the test above that a double load, namely, 75-mm. Gun, Model 1916, with limber, was towed, but it is contemplated that if used in service the load for this tractor would be limited to a single unit, namely, either a field piece or a caisson, and the tests which will be continued with this equipment will be to determine the capabilities of the Fordson equipment in reference to the single load only.

The accompanying illustration shows the Fordson tractor, with the Hadfield-Penfield adapter attached.

Rock Island Arsenal Notes

Report of Design Section.—The design work in the self-propelled Gun Carriage section of the Artillery Division has been moved from Washington to Rock Island Arsenal and has been made a part of the recently organized Design Section.

The Design Section has started the development of a new tank to supersede the present Medium Tanks, Models 1920 and 1922. Many preliminary studies have been made and the final studies will be ready in the near future for presentation to the Chief of Ordnance for approval.

Several new features are incorporated in this design, and, if successful, should greatly increase the tactical advantages of this tank. The weight will be reduced to somewhere under fifteen tons when fully equipped for action. Its rate of speed, under normal conditions, will be 12 miles per hour, but capable of bursts of speed up to 18 miles per hour.

The track is of a new design patterned after a track developed in England, the unique feature being its ability to form the arc of a circle when turning and thereby preventing the slipping of the track shoes over the surface of the road.

The steering control differential is another new feature. By releasing the steering clutch and applying the brake to one side of the differential the power of the engine is divided between the driving sprockets so that the speed of one track is reduced and the speed of the other track proportionally increased, allowing all the power to be transmitted to the driving sprockets and permitting the tank to turn without any appreciable reduction in speed.

All the controls are to be operated pneumatically thereby reducing the manual effort on the part of the driver to a minimum. This enables the placement of the driver in a more advantageous position where all-around vision may be had from the turret of the tank.

The armament consists of one six-pounder and two machine guns as well as an anti-aircraft gun to be operated through the turret of the tank. Anti-gas devices are installed for the protection of the crew.

Report of Production Departments.—The U. S. Army Ordnance Department Exhibits at the American Legion Convention, New Orleans, La., on October 16 to 20th inclusive, proved to be very popular with the Legionnaires. Space for the exhibit was supplied at the Louisiana State Museum at Jackson Square. The exhibit was in charge of a group of civilian personnel sent from Rock Island Arsenal. The majority of the material was also shipped from Rock Island Arsenal.

The Browning Machine Gun, Model 1917, the Browning Automatic Rifle, Model 1918, 37-mm. Gun and the German Machine Guns attracted considerable attention. The Anti-aircraft Machine Gun Trailer, Cynget Type, created much favorable comment.

The exhibit of rifles, bayonets, trench knives, rifle grenades, pistols and revolvers proved very interesting. There were all types of small arms, the U. S. Muzzle Loading Musket, Cal. .69, M. 1833; the Model 1847 Carbine, Cal. .52, smooth bore; the U. S. Springfield Flint Lock Musket, Cal. .69, M. 1829, and U. S. Harpers Ferry Muzzle Loading Muskets, paper cap, Cal. .50, M. 1857, proved irresistible.

The 155-mm. G. P. F. Gun Carriage and Limber, and the Trench Mortars brought forth much favorable comment. The 75-mm. British and American Field pieces were also on exhibition. Considerable interest was created by the 155-mm. Howitzer Carriage, Model 1920. The new and experimental designs in field artillery were much sought after, many questions were asked regarding their weight and range and general performance.

The most popular portion of the exhibit was the automotive material. The 2½-ton Divisional Tractor and the 5 and 10 ton tractors were operated several times each day. The 6-ton Tank and Medium "A" Tank (Experimental), Model 1922, were operated several times each day and opportunity was given to the admiring crowd to ride in them. The Experimental Tank, Model 1922, with its new track and cable suspension and its pneumatic control was always surrounded by a group of interested spectators who expressed surprise at the speed which the tank attained. The novelty of the pneumatic control escaped the attention of no one.

The experimental 900-lb. Tractor Power Cart and the 800-lb. Reconnaissance Tractor were very interesting. These vehicles are made largely of light aluminum alloys and are not only equipped with light tracks but the bodies are made so that they can float. The 800-lb. Reconnaissance Tractor is, in addition, supplied with a propeller and rudder for maneuvering in water. Photographs of these vehicles while in operation in water were available at the exhibit.

The optical equipment drew considerable attention. The rangefinders and the telescopes were examined by many.

The exhibit of Demolition Bombs, Stokes Mortars, shells and fuses, many of which were sectionalized, proved of interest to all the visitors. Many questions were asked concerning the operation of the sectionalized 75 millimeter shell and shrapnel.

All visitors and especially those who had experience during the war with machine guns had heard of and were anxious to see the Browning Machine Gun, Cal. .50, Model 1921, the functioning of this weapon particularly pleased the spectators and the possibilities of such a machine gun were freely discussed.

The appearance of certain of the tractor-drawn artillery and the tanks in the parade was greeted with much applause.

Watertown Arsenal Laboratory Notes

An X-ray apparatus for the investigation of metals has recently been installed in the laboratories of the Watertown Arsenal. This equipment is probably the most complete of its kind which has as yet been assembled for other than therapeutic uses.

The laboratory occupies about 1,500 sq. ft. of floor space

divided into two operating rooms, a preparation room, control room, dark room, and office. The larger of the operating rooms, which is 15 by 20 by 10 feet, contains the high power radiographic apparatus. On account of the high power X-rays used in this work, it is necessary to provide ample protection to the operator and others who may be in the vicinity of the apparatus. The ceiling and all four walls of the operating room are completely covered with ¼" lead sheathing, approxi-

Operating Room for the Radiography of Metals

mately 12 tons of lead being utilized in this protective covering. Ventilation is obtained by an exhaust fan installed in a lead protected ventilating duct. The operator is stationed outside of the operating room in an adjacent control room. He has a view of the X-ray tube, meters, etc., through a large lead lined periscope. This periscope is a unique feature of the installation in so far as it gives an excellent view of the apparatus, and, at the same time, completely protects the operator from the action of the X-rays. Further protection is afforded, and the possibility of accidents reduced to a minimum, by a cut-out switch on the sliding door entering the operating room. This switch is so arranged that the apparatus cannot be operated until the door is completely closed. Another switch, in series with the cut-out switch on the door, is provided inside the operating room so if the operator finds it necessary to be in the room at any time with the door closed, he may protect himself in case anyone should attempt to operate the machine.

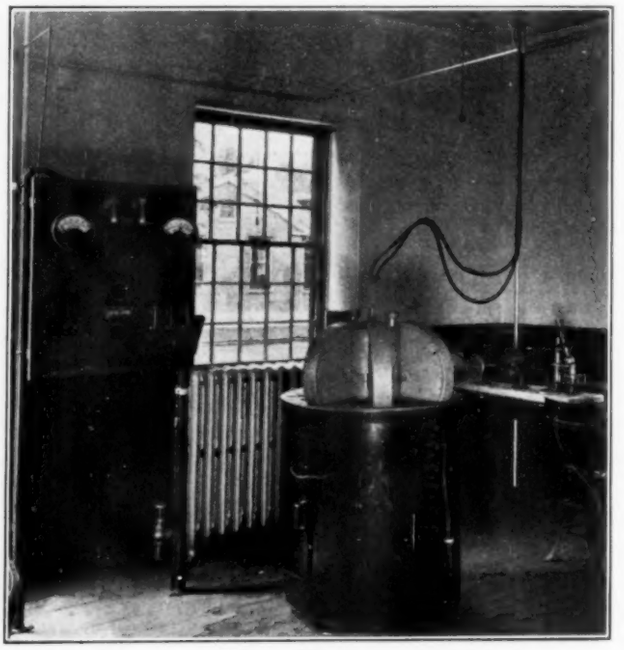
The apparatus consists essentially of a Coolidge X-ray tube, a step-up transformer, a high tension rectifying device, meters for reading the tube current, and a stabilizer for preventing surges through the tube. The X-ray tube operates at a maximum of 200,000 volts and 8 milliamperes. This is the most powerful Coolidge tube thus far developed commercially. The transformer operates at a primary voltage of 220 and delivers current of 200,000 volts to the high tension rectifier. The rectifier is a Snook machine and consists essentially of a revolving commutator with four contact arms insulated for 300,000 volts. It is driven by a half horse power motor at synchronous speed. The rectifying action is similar to that of the commutator of a direct current dynamo, the arms making contact at maximum voltage and breaking contact at a lower voltage. Contact with the four sets of shoes is made through a small air gap, and when properly adjusted there is very little sparking. The positive and negative shoes are connected through ⅝" brass tubing which is carried along the ceiling on pillar insulators to a point above the X-ray tube. Connection with the tube is made through flexible conductors carried on spring rolls which permits manipulation of the tube, and at the same time takes up the slack in the cord conductors.

Two milliameters are inserted in the negative lead. These are carried on a support from the ceiling, the stabilizer being carried on the same support. A Kearsley stabilizer developed in the General Electric laboratories is used, and functions so as to keep the thermionic current between the cathode and target constant. The filament of the cathode is energized from a separate transformer, the secondary of which is insulated for 300,000 volts. One end of the secondary is connected to the brass tubing which forms the negative side of the high tension line, and the other is carried through this tubing to the stabilizer and thence to the filament. The current through the tube is varied by an inductance regulator in the primary of the filament transformer, which varies the current through the filament and consequently varies the current across the tube. The voltage across the tube is regulated by a variable resistance in the primary of the main transformer. All of the controls are mounted on a control panel which is located outside of the operating room, in the control room previously referred to.

The preparation room, which is also used for the storage of materials, contains a work bench where specimens are prepared for examination. It is necessary to fit a lead mask to the object to be radiographed, in order to prevent fogging of the film by fluorescent radiation from other objects in the room. It is also necessary to protect certain thin portions of a casting or forging with lead during exposure, thus adjusting the exposure of thicker portions. This room also contains an illuminator and a stereoscope for studying negatives obtained. In order to locate the depth of a fault existing beneath a surface of metal, it is necessary that the X-ray picture be viewed in three dimensions. That the picture may be viewed in three dimensions, two negatives are taken with the tube in two positions separated by 2½ inches. When the resulting negatives are viewed stereoscopically, the superimposed images give a perfect illusion as to the depth so that one can actually see the inside of the metal with the faults correctly located in three planes. The stereoscope is an elaborate and very necessary part of the X-ray equipment. Negatives up to 18 inches square can be examined.

The smaller of the operating rooms contains a complete installation for the X-ray analysis of metallic crystals. Such analysis is the outcome of recent theoretical research, and since its application to industrial testing is new, a brief description of the diffraction method may be of interest.

Diffraction of X-rays can be accomplished by passing X-rays through a crystal. The regularly spaced atoms in a crystal fall into definite equidistant planes for certain orientations of the crystal, the planar distances depending upon the orientation of the crystal, the crystal type, and the material of which



Operating Room for Crystal Examination

the crystal is composed. X-rays falling on any system of planes will be diffracted at a definite angle when the incident angle has the proper value. First, second, and third order spectra may be found. If X-rays of various wave lengths fall on a crystal in any given orientation an X-ray spectrum will result similar to the spectrum of light from a plane grating.

If any crystalline substance is ground to very fine particles, and these particles are thoroughly mixed, the beam of X-rays falling at any angle of incidence will find sufficient particles

oriented so as to give a diffraction from each of the possible systems of planes of atoms in the crystal. If, in addition, the beams consist of waves all having the same wave length, there will result from this a spectrum, each of the lines of which will represent one possible system of planes in the crystal. Moreover the angle of refraction in each case will be determined by the planar distances. By measuring this angle the unit crystal can be built up and crystalline structure worked out.

The apparatus for this work consists of a molybdenum target water-cooled Coolidge tube operating at 50,000 volts and 25 milliamperes. With 50,000 volts on the tube the molybdenum target gives a radiation which is very nearly monochromatic. The transformer for supplying the high potential for the tube and for lighting the filament is inclosed in a metal case thoroughly grounded. The case contains also a stabilizer and a ventilating fan. Due to the fact that the target is water-cooled, the tube is self-rectifying so that the alternating potential of the transformer can be applied directly to the tube. The tube itself is mounted vertically on a brass cylinder with the face of the target opposite an elaborate slit system which directs the rays on to the specimen of ground crystals contained in capillary glass tubes. The cassette in which the film is mounted is a quadrant of a flat cylinder of approximately 8 inch radius with the specimen in the axis. Brass absorbing screens take up the direct radiation. The diffracted rays appear as dark lines of varying density across the film, which is mounted in the circumference of the cassette. This arrangement of black lines constitutes the spectrogram of the material under investigation. By means of a special logarithmic scale supplied with the instrument, and special charts, the type of crystal can be found, the planar spacings worked out and the atomic packing determined. When a mixture of substances is present the separate components are worked out independently. Since the spectrograms of no two substances are identical, it is not always necessary for analytical purposes to work out the crystal structure. A comparison of the spectrograms will often afford all the information sought.

Although considerable work has already been done on the crystalline structure of iron, it is not believed that any systematic attempt has heretofore been made to determine the spectrograms of various steels which have undergone different treatments. It is the intention of Watertown Arsenal to determine the spectrograms of a number of steels whose previous history and physical properties have been very accurately determined. The field to be investigated will be of a very practical nature, and an attempt will be made to interpret the various spectrograms in terms of the physical characteristics of the material examined.

Figure 1 shows the interior of the operating room equipped for the radiography of metals. In this room forgings and castings will be examined for interior defects, such as slag, streaks, blow holes, etc.

Figure 2 shows the operating room equipped for crystal examination.

It is the intention of the Ordnance Department to publish in the technical press the results obtained in the contemplated investigations.

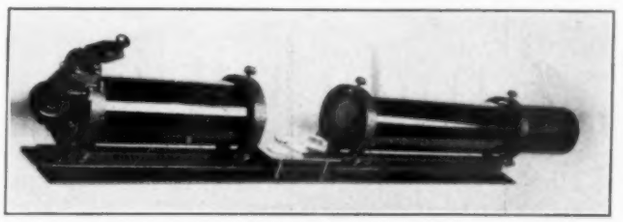
Frankford Arsenal Notes

Considerable attention has been given recently to the improvements in the Optical Laboratory at Frankford Arsenal and the devising of more satisfactory methods of determining the constants of optical glass and more suitable methods of inspection of finished optical parts. The following instruments have recently been designed and manufactured for use in the Optical Laboratory:

Immersion Apparatus.—This instrument is for use in sorting, inspecting for striæ, and determining the mean index of optical glass in any form by the immersion method. It permits the examination of irregular shaped pieces of optical glass without the necessity of working the piece into the prism form, as ordinarily required, and at the same time may be used to determine the index of lenses in the finished state, which becomes necessary in the examination of optics manufactured from glass whose characteristics are not known. It is also very well adapted to the critical examination of optical glass in slabs with opposite faces plane polished, and for the detection of bad glass and prism action in plates supposed to be plane parallel.

It is based on the well known pin hole or knife edge test for an objective, the sensitivity being increased by utilizing the residual chromatic aberration of the large lenses.

The advantage of having a well built instrument capable of maintaining its adjustment has justified the design and construction of this device. The specimens are placed in a glass tank which contains a mixture of liquid whose composition



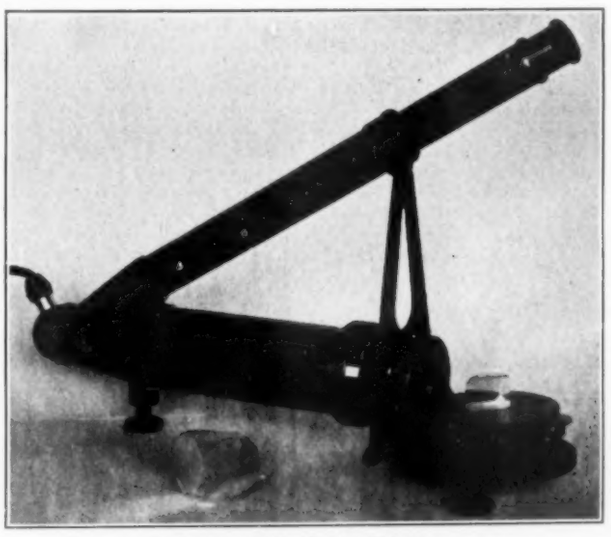
Immersion Apparatus

is altered until the index of refraction of the liquid matches that of the sample, which condition is clearly indicated by looking into the eyepiece of the instrument. The index of the liquid may be determined at any time by placing in the liquid samples of glass whose index of refraction is known, and consequently that of the sample which is under examination. Convenience in use was kept in mind, and it will be noted that the user may introduce a specimen and move it about while comfortably seated at the eye piece. Special features are the device for quickly adjusting the pin hole or knife edge to any desired position in the focal plane, and the observing telescope giving an erect and magnified field of view and placing the exit pupil in a position conducive to efficiency.

Universal Prism Testing Instrument.—The original intention in the design of this instrument was to provide a convenient and reliable device for the rapid testing of Porro prisms for definition and angle errors, but it soon became apparent that the instrument would serve almost equally well for the testing of practically all types of prisms used in our fire control instruments.

The fundamental principle embodied in the design is that every prism should be tested with light passing through it in the same way as will be the case when the prism functions as a part of an optical instrument. Experience has shown that when prisms are not tested in this manner good prisms are sometimes rejected and bad prisms sometimes passed.

The basis of the instrument consists in the examination of



Instrument for Testing Prisms

the images reflected and transmitted by the various polished surfaces of the prism. Angular errors between the faces of the prism as well as faulty definition from whatever cause are shown up instantly, and methods are provided for measuring the amount of angular error.

The unusual form of the instrument was adopted as being conducive to comfort and speed. Like all instruments of a universal character it is better adapted to some classes of work than to others. The aim of the designer has been to

make it most suitable for those optical parts which experience has lead us to expect in greatest numbers.

Wide Angle Eyepiece.—Investigations have been carried on for some time toward designing a wide angle eyepiece for enlarging the field of view of various instruments. Considerable progress has been made in the work and an eyepiece having an apparent field of 70 degrees and very satisfactory general characteristics has been manufactured and applied to a pair of binoculars. This sample eyepiece appears equal in all respects to the best of foreign manufacture. In view of the fact that at this time the best apparent field of view obtainable in our optical instruments has been in the neighborhood of 50 degrees, the enlarging of this apparent field to 70 degrees marks a very considerable step forward.

Ammunition Division Notes

Sympathetic Detonation Tests of High Explosive Shell.—At the end of the World War the Ordnance Department had on hand considerable quantities of loaded high explosive shell. These shell were stored in the various Ordnance establishments throughout the country. Those which existed in the larger quantities were the 75-mm. shell, the 155-mm. shell and the 8-inch shell. Some were filled with trinitrotoluol, some with 50-50 amatol (one part trinitrotoluol and one part ammonium nitrate) and others with 80-20 amatol (one part trinitrotoluol and 4 parts ammonium nitrate). All of the shell were manufactured to take the point detonating fuse and were fitted with adapters and loaded boosters.

From the point of view of safety, the question as to the best

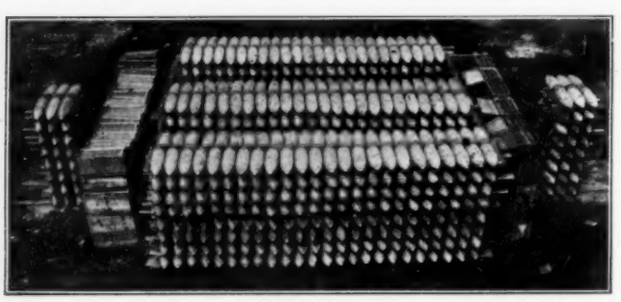


Fig. 1

way to pile such shell and the arrangements of piles in storage at depots or at dumps in the field could not be satisfactorily answered by reason of the fact that little was known concerning the hypothesis controlling the propagation of the detonating wave.

High explosive shell, 155-mm. and above, are usually piled in rows one or two shell deep, tiers of shell being separated by one-inch boards. It was known that the detonation of one shell in the pile would in all probability cause sympathetic detonation of the entire pile. Supposing, however, there were two or three other piles of shell near the detonating pile, the question as to what should be the distance between the detonating pile and adjacent piles, in order that the adjacent piles might not detonate, could not be satisfactorily answered. Would the interposing of a barricade between adjacent piles of shell check the propagation of the detonating wave and if so of what material could it be constructed and how thick must it be? Innumerable conditions might be assumed with various premises but at the best, conclusions could only be guessed at.

The necessity for knowledge concerning the propagation of the detonating wave between piles of shell naturally increases with the number of shell to be stored or handled. With sufficient knowledge regulations governing the arrangement of shell in storage in magazines, at field dumps or in transit, might be laid down so that should a detonation occur the damage therefrom would be reduced to a minimum.

During the present year the Ordnance Department has been obliged to evacuate some of its storage depots. Considerable quantities of loaded shell would have to be moved and stored in permanent depots, thereby concentrating large quantities of shell in these depots. Furthermore sufficient storage space would not be available in permanent depots for all shell. Obsolete shell and shell of doubtful serviceability would have to be declared surplus and sold for an insignificant return to the Government.

In view of these conditions the Ordnance Department considered the time propitious to carry out tests, on the sympathetic detonation of high explosive shell using surplus shell on hand for the purpose. In April, 1922, a committee was appointed by the Chief of Ordnance to prepare a program and supervise the tests. The committee consisted of a representative of the Ordnance Department Technical Staff, a representative of Ammunition Division, Field Service, a representative of the Ammunition Division, Manufacturing Service, and a representative of the Aberdeen Proving Ground. The Aberdeen Proving Ground was selected as the place to carry out the tests. A program was prepared and the first tests carried out on April 14, 1922.

From the first tests it was found that the 8-inch shell loaded with 80-20 amatol were the most sensitive to sympathetic detonation and in the later experiments in which large quantities of shell were detonated the 8-inch shell loaded with 80-20 amatol were used.

In order to give some idea of the nature of the tests, there appears immediately following the report of test 11(a) and 11(b) carried out at the Proving Ground in August, 1922.

Test 11(a) made August 21, 1922:

Material: 1248 8-inch H. E. shell loaded with 80-20 amatol with Mark II adapters and boosters fitted with Type A lifting plugs.

Three piles each consisting of two rows of shell placed base to base each row 24 shell long and 8 shell high, 384 shell in

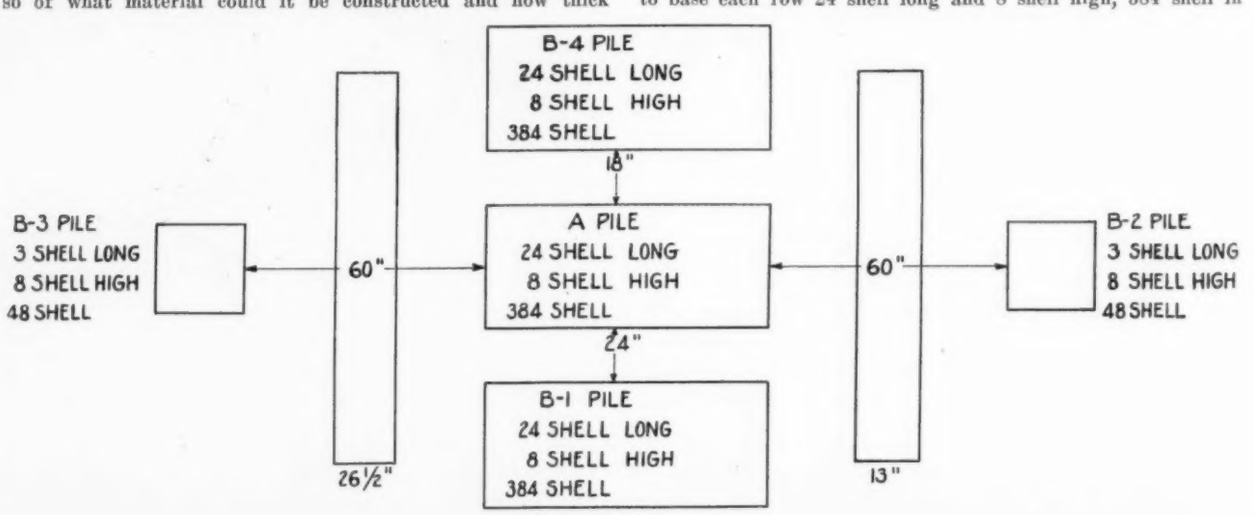


Fig. 2

each pile. These piles were designated the A, B-1 and B-4 piles.

Two piles each consisting of two rows of shell, rows placed base to base each row 3 shell long and 8 shell high.

The B-1 pile was placed opposite the A pile with a distance from noses of A pile to noses of B-1 pile of 24 inches.

The B-4 pile was placed on the other side of the A pile with a nose to nose distance between the A and B-4 piles of 18 inches.

Fig. 3

The B-2 and B-3 piles were placed beside the A pile one on each side with a distance of 5 feet between the A and B-2 piles and also between A and B-3 piles. In the center of the aisle between the A and B-2 piles was placed a barrier, built of 1-inch oak boards of dimensions similar to a row of 75-mm. shell boxes placed end to end along the aisle. The outside width was 13 inches. Between the A and B-3 piles was placed a barrier built of 1-inch boards and of the same dimensions as a barrier of 75-mm. shell boxes placed side by side with the length of the box across the aisle. The outside width of this barrier was 26½ inches, the length of the 75-mm. shell packing box. Both barriers extend from opposite the middle of the B-1 pile to opposite the center of B-4 pile and were of the same height as the piles of shell. Barriers were filled with loose sand.

The general arrangement is shown in Figure 1 and Figure 2.

One shell in the middle of pile A was detonated by means of a No. 6 blasting cap inserted in a fuse and fired electrically. The A pile detonated with high order.

Results: The B-1 pile apparently detonated with high order. The following were recovered:

Four whole shell.

Several fragments indicating that shell were simply broken up.

Many fragments indicating high order.

The B-2 pile did not detonate.

Several whole shell were recovered as well as fragments indicating broken up shell. All whole shell were found at a distance of ¾-mile from crater. Signs of other shell were found which went farther away but which could not be recovered on account of marshy ground.

B-3 pile did not detonate. Two large pieces of shell with explosive intact were recovered. These are shown in Fig. 4. It is thought that closeness of marsh in this direction about 600 yards, is the reason for not finding any whole shell.

B-4 pile did not detonate. About 30 whole shell and many fragments, indicating broken shell, were recovered. No reason can be assigned for this failure in view of the action with the B-1 pile.

Figure 3 shows the crater made by the detonation of the shell used in this test.

Conclusions from Tests: The barrier placed between piles five feet apart laterally will effectively prevent transmission of the detonation in this direction.

It is proposed in the next test to substitute for the sand filled barriers a barrier made up of boxed 75-mm. H. E. shell ammunition. This information will be valuable for shell storage in the field as it will indicate the possibility of using boxed ammunition as a barrier.

It is considered possible that the detonation in the B-1 pile was caused by a fragment of the A pile striking on the end of one of shell of the B-1 pile, crushing in the head and booster sufficient to cause a detonation of the booster charge which set off that shell and caused the detonation of this pile. Such a method of setting off the B-1 pile may allow for delay sufficient for some of the shell in the pile to be thrown about by the force of the explosion of the A pile. This might account for the whole and broken shell as in no other case in this test has any pile shown sign of giving high order and broken or whole shell.

Test No. 11(b) made August 31, 1922:

Material: 1248 8-inch H. E. shell loaded with 80-20 amatol with Mark II adapter and booster casings fitted with Type A lifting plugs.

Arrangement: Three piles designated as A, B-1, B-4, of two rows each, rows placed base to base each row 8 shell high, 24 shell long, 384 shell each pile.

Two piles designated B-2 and B-3 of two rows each, rows placed base to base, each row 3 shell long, 8 shell high, 48 shell each pile.

Distances A to B-1 pile 36 inches, nose to nose.
A to B-4 pile 24 inches, nose to nose.
A to B-2 pile 60 inches laterally.
A to B-3 pile 60 inches laterally.

Between A and B-2 pile was placed a barrier of boxed 75-mm. H. E. shell ammunition placed with the length of the boxes across the aisle. The barrier extended from opposite the middle of the B-1 pile to opposite the B-4 pile and was as high as the piles.

Between the A and B-3 piles was placed a barrier of boxed 75-mm. H. E. shell ammunition placed with the boxes lengthwise along the aisle. The barrier extended from opposite the middle of the B-1 pile to opposite the middle of the B-4 pile and was as high as the piles of shell.

Fig. 4

The general arrangement is shown in the Figure 1 and in Figure 5.

One shell in middle of A pile was detonated.

Results: A pile detonated with high order. B-1 pile evidently did not detonate completely.

Many whole shell were recovered and many fragments, indicating broken up shell. A few fragments were recovered, indicating high order of detonation. Whole shell from this pile or from the B-1 pile of the previous test were found about 2 miles from place of detonation.

B-2 pile did not detonate. Several whole shell recovered at distance of ¾ mile from pile. Others probably went farther.

Barrier between B-2 and A pile showed many broken shell or low order explosions. Some whole shell recovered had no booster or explosive charge left in shell.

B-3 pile did not detonate. Two shell from original pile recovered. Others evidently thrown into marshy ground only about 600 yards away. These could not be located or recovered.

Barrier between A and B-3 pile. No fragments found.

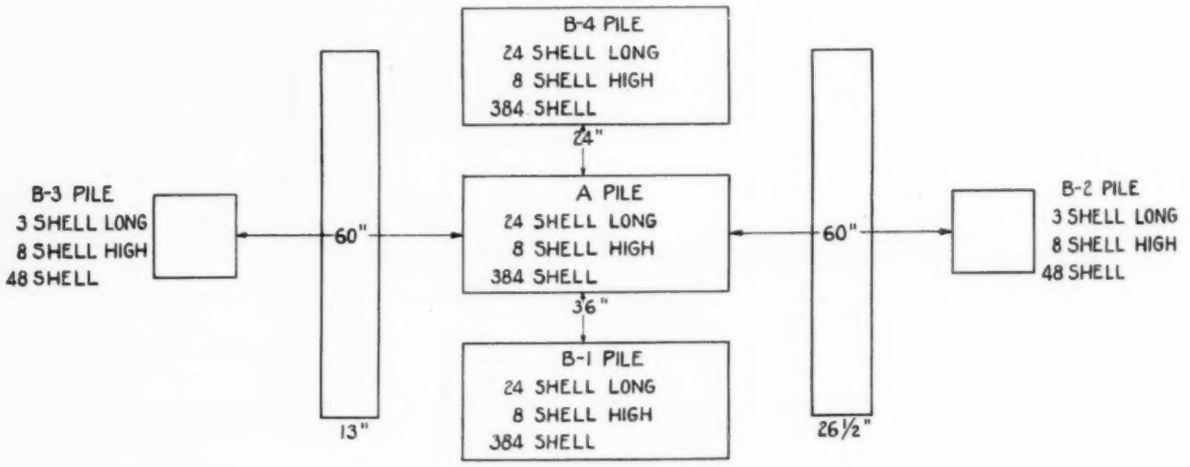


Fig. 5

B-4 pile detonated completely although a few of the fragments give indications of being simply broken up. No whole shell recovered. Fig. 6 shows some of these fragments.

From all tests carried out up to the present time the following comments are made:

1. A shell detonating with high order in a standard magazine pile will set off the whole pile.

2. When shell are piled similar to standard magazine piles, each pile of double row, rows placed base to base and tiers of shell separated by 1-inch boards, piles adjacent laterally will be set off at rather large distances. Lateral distances up to 200 inches were obtained when the test for this distance was discontinued. It is very evident that when piles are placed with distances less than this a barricade must be erected between piles.

Fig. 6

3. With the distance laterally reduced to 60 inches it was found, with piles up to 24 shell long, that a barricade of 75-mm. shell boxes filled with sand would effectively stop the detonating wave. This was true with the boxes placed lengthwise across the aisle or lengthwise along the aisle and with the barricade built as high as the pile of shell. Barricades made of boxed 75-mm. H. E. shell rounds were built in both ways and effectively stopped the detonation. It can, therefore, be assumed that any boxed shrapnel ammunition and 75-mm. shell ammunition will effectively stop transmission laterally of detonations from the initiating pile.

4. It is believed that there will always be danger of detonating adjacent piles from nose to nose, due to fragments striking the nose of the shell, crushing in the booster and detonating the booster charge.

5. A test was carried out by burning a carload of 200 8-inch shell loaded with 80-20 amatol. About 8 minutes after starting the fire the entire 200 shell detonated. This showed that there would always be danger of complete detonation of the contents of a car loaded with high explosive shell in case the car should catch on fire.

6. In a test under which was burned a pile of 512 boxes of complete rounds of 75-mm. ammunition, it was concluded that a burning pile of such ammunition would not detonate as a whole but the individual shell and powder charges would explode as the fire reached them. Detonations started in one box would probably not be transmitted to shell in other boxes.

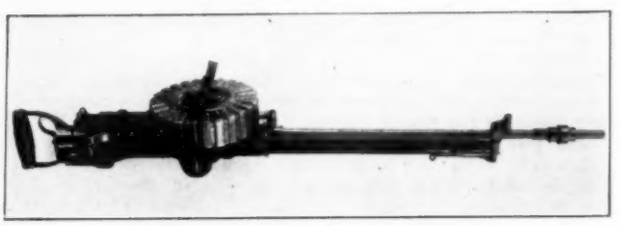
7. In a test under which was exploded one shell in a box of complete rounds of 75-mm. ammunition, which box was one in a pile of 49 boxes, it was found that the detonation of this shell caused all shell in the box to detonate but that the detonation would not be transmitted outside of the box in which it was originally started. Therefore it would appear that the damage which might result from a fire or the detonation of one shell in a pile of boxed 75-mm. ammunition would be quite local.

8. In a detonation of any considerable quantity of high explosive shell such as a whole magazine pile of 400 or more shell, whole shell and fragments from either the exploding or adjacent piles would be thrown a distance of two miles.

9. Before a final study of the proposition can be undertaken and a complete report prepared, there yet remains to be conducted tests of piles of shell detonating on a concrete floor and in an inclosed building. It is further intended to check the results obtained with the 8-inch shell by using 155-mm. and 10-inch shell. A comparison between the sensitiveness of 8-inch shell loaded with amatol and 8-inch shell loaded with TNT will be made.

Springfield Armory Notes

New Model Lewis Aircraft Machine Gun.—The improved model Lewis Aircraft Machine Gun constructed by the Savage Arms Corporation has been given a preliminary firing test (which was witnessed by Lt. W. R. Fletcher of McCook Field and Mr. Baldwin of the Savage Arms Corporation) and sent to Aberdeen Proving Ground for further test. This gun embodies several departures from the standard Lewis aircraft construction, principally for the purpose of increasing its rate of fire and making the action positive under all conditions.



Experimental Lewis Aircraft Machine Gun
Constructed by the Savage Arms Corp., under the supervision of Springfield Armory.

It is also equipped with a finger trigger in the spade grip in place of the usual trigger and guard arrangement.

Results obtained in the test here were encouraging except for the performance of the extractors which at first was very poor. A supplementary test was then conducted, using modified extractors made in accordance with the instructions of Mr. Baldwin with good results, there being only three extractor stoppages during the 4,100 rounds fired.

Further action in connection with the development project will depend upon the results obtained in tests at Aberdeen and probably later at McCook Field.

Nine proof loads developing 70,000 pounds per square inch pressure have been fired in two caliber .50 aircraft machine guns. Five of these rounds were fired in one gun with no ill effects. Four were fired in another gun in which the rear of the barrel was expanded about .004 inch. No other adverse effects were observed.

When more of this proof ammunition is available further tests will show whether the standard proof charge should develop 70,000 pounds per square inch pressure or whether this should be somewhat reduced. The normal chamber pressure is 50,000 pounds per square inch.

War Surplus

The Story of the War Department's Sale of Its Surplus Property

The Sales Promotion Section of the Office of the Director of Sales, War Department (in charge of Major J. L. Frink, U. S. Army) has issued a booklet telling the story of the War Department's Sales of its surplus property, what it has for sale, where it is located, and how to buy it.

This booklet contains extensive information as to the classes of material the War Department has scheduled for disposition, and their methods of sale are clearly set forth in a manner that is of practical interest to prospective buyers. There are also some valuable "hints to buyers," and under the heading "Look First to the War Department for Sales," there are the following suggestions:

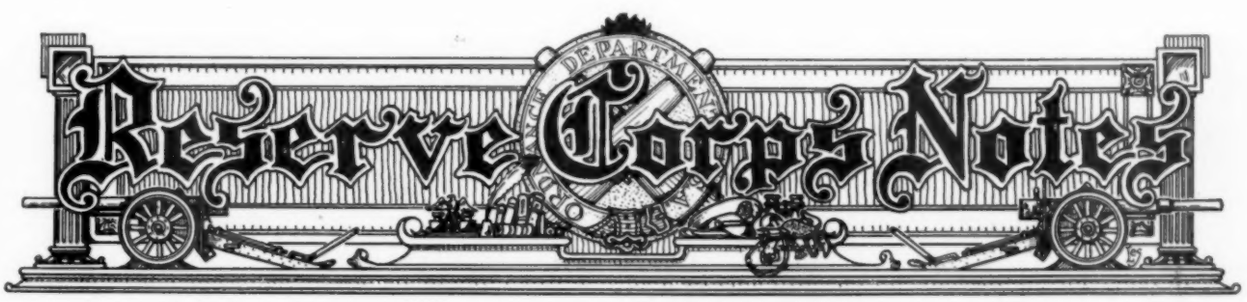
"In buying, consider first the War Department as your source of supply. There are several very good reasons for this.

"First: The stocks are enormous. You are reasonably certain to find just the materials you need.

"Second: The sooner these stocks are absorbed into the industrial fabric, the sooner your Government gets back to a smooth, economical basis of operation. You have a genuine duty to yourself and your country there.

"Third: You may buy some of this material later anyhow. But then you will have to buy it in the open market, at a price which gives someone else a profit. That profit might have been yours, had you bought of the Government.

"Thousands of far-sighted business men have taken advantage of these War Department sales. Why not you?"



Captain Read Wipprecht, Ordnance Department, has been relieved from assignment at Woodbury Ordnance Reserve Depot, and ordered to report for duty in the Office of the Chief of Ordnance, Military Personnel Section. Captain Wipprecht will be placed in charge of Organized Reserves and in this capacity will handle appointments, promotions, assignments, training and dissemination of information.

As a part of the Army Correspondence System the Ordnance Department is offering to officers and enlisted men of the Organized Reserve and to qualified civilians who may volunteer, a course of study covering the military fundamentals largely common to all branches of the Army and the organization and methods of administration of the Ordnance Department. The courses are as follows:

ORDNANCE COURSE "A"

Subcourse I. Administration, Discipline and Courtesies.

The military policy of the United States, general organization of the Army of the U. S. and problems of administration which will immediately confront the citizen officer in case of a great national emergency. These problems concern mobilization, interior economy of the company, property accountability, other company records, individual records of soldiers, company field desk and company reports, periodical reports and company returns and military correspondence; military discipline, courtesies and customs of the service. 34 hours.

Subcourse II. Ordnance Administration.

General scheme of administration of the Ordnance Depart-

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ment; Organization, Field Service and its functions. 19 hours.

Subcourse III. Military Hygiene.

Fundamentals of personal and organization hygiene. 15 hours.

Subcourse IV. Military Law.

Those phases of elementary law governing the administration of military justice with which all officers of the Army should be acquainted. 30 hours.

Subcourse V. Ordnance Law.

Law with special reference to the Ordnance Department; finance and property accountability. 35 hours.

Subcourse VI.

Infantry drill, guard duty, map reading. Elementary treatment with special reference to Ordnance troops. 16 hours.

Members of the Army Ordnance Association desiring to take advantage of these courses should communicate with the address given below, which is nearest place of residence:

The Commandant, Training Center, First Corps Area, Fort Constitution, N. H.
Headquarters 2d Corps Area, Governors Island, N. Y.
Chief of Staff, 79th Division, Schuylkill Arsenal, 2620 Grays Ferry Rd., Philadelphia, Pa.
Chief of Staff, 80th Division, 7th & Franklin Streets, Richmond, Va.
Chief of Staff, 99th Division, 604-A Chamber of Commerce Bldg., Pittsburgh, Pa.
Chief of Staff, 62d Cavalry Division, 27 W. Washington St., Hagerstown, Md.
Chief of Staff, Non-divisional Group, 207 Dauphin Bldg., Harrisburg, Pa.
Headquarters 4th Corps Area, Fort McPherson, Ga.
Chief of Staff, 83d Division, Columbus Barracks, Ohio.
Chief of Staff, 84th Division, 503 N. Meridian St., Indianapolis, Ind.
Chief of Staff, 100th Division, Morrison Bldg., Charleston, W. Va.
Chief of Staff, 64th Cavalry Div., Post Office Bldg., Louisville, Ky.
Chief of Staff, 5th Army Corps, Fort Thomas, Ky.
Headquarters 6th Corps Area, 1819 Pershing Rd, Chicago, Ill.
Headquarters 7th Corps Area, Army Bldg., Omaha, Nebr.
Corps Area Correspondence School, 8th Training Center, Fort Sam Houston, Texas.
Headquarters 9th Corps Area, Presidio of San Francisco, Cal.

Application for enrollment should be typed in duplicate in the following form:

APPLICATION FOR ENROLLMENT
Army Correspondence Courses

Place .....
Date .....

From:
To:
Subject: Application for enrollment in Course.....

Branch.....

1. Request is hereby made for enrollment in the Army Correspondence Course named above.
2. My previous military education has been as follows:

Signature.....

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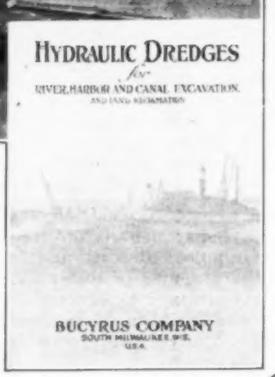

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